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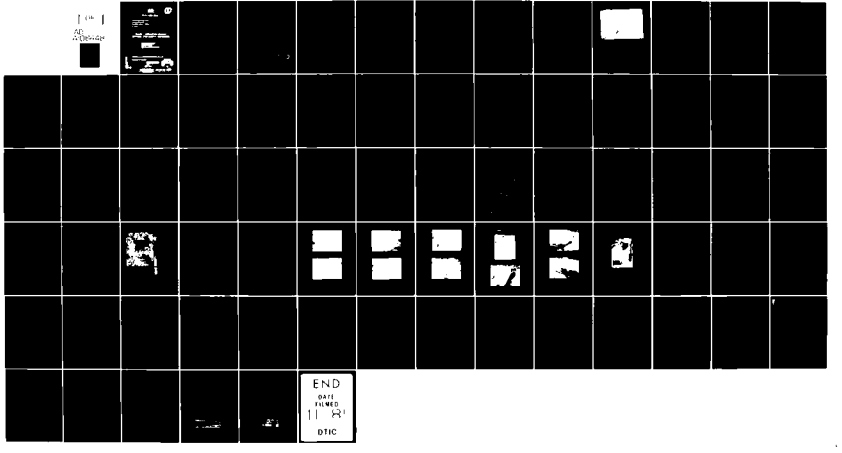

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This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Brushy Creek Mine Water Clarification Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Brushy Creek Mine Water Clarification Dam (MO 30330).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been clasified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division — 20 MAY 1981 (Date)

APPROVED BY: SIGNED
Colonel, CE, District Engineer — 22 MAY 1981 (Date)

BRUSHY CREEK MINE WATER CLARIFICATION DAM

Iron County, Missouri

Missouri Inventory No. 30330

Phase I Inspection Report
National Dam Safety Program

Prepared by

Woodward-Clyde Consultants
Chicago, Illinois

Under Direction of
St Louis District, Corps of Engineers

for
Governor of Missouri
April 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Brushy Creek Mine Water Clarification Dam
State Located	Missouri
County Located	Reynolds
Stream	Lick Creek
Date of Inspection	22 October 1980

Brushy Creek Mine Water Clarification Dam, Missouri Inventory Number 30330, was inspected by Richard Berggreen (engineering geologist), Leonard Krazynski (geotechnical engineer), and Sean Tseng (hydrologist). Mr John Kennedy of St Joe Lead Company was present for part of the inspection period.

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, US Army, Washington, DC, with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines represent a consensus of the engineering profession. The safety inspections are intended to provide for an expeditious identification based on available data and a visual inspection, of those dams which may pose hazards to human life and property. In view of the limited nature of the study, no assurance can be given that all deficiencies have been identified.

The St Louis District (SLD), Corps of Engineers has classified this dam as having a high hazard potential. The estimated damage zone length, as determined by the SLD, extends approximately two miles downstream. Within the damage zone are several occupied dwellings. The contents of the downstream hazard zone were verified by aerial reconnaissance.

The dam is classified as small due to its 38.5 ft height and 249 ac-ft storage volume. The small dam classification includes dams having a storage volume between 50 and 1000 ac-ft, or a height between 25 and 40 ft.

Our inspection and evaluation indicate the embankment is in generally good condition. No evidence was found of significant erosion, slope instability, disruption of the vertical or horizontal alignment of the dam, or detrimental vegetation. Seepage and

stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

Hydrologic/hydraulic analyses indicate that a 1 percent probability-of-occurrence event (100 year flood) will not result in overtopping of the dam. These analyses also indicate that the dam will be overtopped for a hydrologic event which produces greater than 25 percent of the Probable Maximum Flood (PMF). The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. On the basis of the broad downstream valley and the relatively large distance to the nearest structure in the downstream damage zone, 50 percent of the PMF is recommended as the spillway design flood for this small dam.

The following specific remedial measures and additional studies are recommended for this dam, to be undertaken without undue delay.

1. Prepare a more detailed hydraulic/hydrologic study and design a spillway capable of passing at least 50 percent of the PMF without overtopping the dam. This design study should include an evaluation of the risk of embankment erosion for storms greater than 50 percent of the PMF.

2. Consider removal of the metal baffles from the spillway section to prevent possible obstructions that could reduce the spillway capacity.

The following measures should be taken as soon as practical.

3. Prepare seepage and stability analyses for the dam in accordance with the "Recommended Guidelines for Safety Inspection of Dams."

4. Remove small trees from the embankment before they become large enough to pose a potential hazard to the dam.

5. Evaluate the feasibility of an effective and practical warning system to alert downstream residents, should potentially hazardous conditions develop at the dam.

6. Initiate a program of periodic inspections to identify signs of slope instability, seepage, turbidity (soil) in the seepage water, or erosion and recommended necessary maintenance.

During these inspections, particular attention should be directed to the spring on the right abutment which is described in this report.

The recommended analyses and remedial work should be performed by or under the guidance of an engineer experienced in the design and construction of earth dams.

It is recommended the owner take action on these recommendations as soon as practical to prevent the development of hazardous conditions at the dam. The recommendations concerning the spillway should be taken without undue delay.

WOODWARD-CLYDE CONSULTANTS

Richard G. Berggreen
Registered Geologist, No 3572, CA

Leonard M. Krazynski, PE, C-14953, CA
Project Manager

OVERVIEW
BRUSHY CREEK MINE WATER CLARIFICATION DAM

MISSOURI INVENTORY NUMBER 30330

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRUSHY CREEK MINE WATER CLARIFICATION DAM
MISSOURI INVENTORY NO. 30330

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BRUSHY CREEK MINE WATER CLARIFICATION DAM
MISSOURI INVENTORY NO. 30330

SECTION 1
PROJECT INFORMATION

1.1 General

a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of the Brushy Creek Mine Water Clarification Dam, Missouri Inventory Number 30330.

b. **Purpose of investigation.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").

c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams," and Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "Engineering and Design National Program for Inspection of Non-Federal Dams," prepared by the Office of Chief of Engineers, Department of the Army; and "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams," prepared by the St Louis District (SLD), Corps of Engineers. These guidelines were developed with the help of several federal and state agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

a. **Description of dam and appurtenances.** The dam is an earth dam constructed of weathered rock and soil from the vicinity of the dam. The purpose of the dam is to impound water pumped from underground mine workings, and allow suspended sediment to settle before the water is released to the natural drainage system. The site is reportedly planned to be the future site of a large tailings disposal dam which may be formed by enlarging and raising the existing earth embankment. The spillway is at the left abutment of the dam (as the observer faces downstream). The spillway has been excavated in the area used as a borrow site for the embankment construction. The spillway and downstream channel are concrete-lined. A construction drain, consisting of a 24-in. diameter iron pipe, passes beneath the dam. The drain was reported to be closed at both the upstream and downstream ends. The downstream end was observed to be closed by a steel plate and a sheet rubber seal.

b. **Location.** The dam is located on Lick Creek, a tributary to Bills Creek and the West Fork of the Black River, about 5 mi southwest of Oates, Reynolds County, Missouri (Fig. 1). The dam is in Section 26, T33N, R2W, on the USGS Greeley, Missouri 7.5-minute quadrangle map (1967).

c. **Size classification.** The dam is classified as small based on its height of 38.5 ft and storage capacity of 248 ac-ft. Guidelines criteria for the small dam classification are: height between 25 and 40 ft or storage capacity between 50 and 1000 ac-ft.

d. **Hazard classification.** The St Louis District (SLD), Corps of Engineers has classified this dam as having a high hazard potential; we concur with this classification. The SLD estimated damage zone length extends approximately 2 mi downstream of the dam. Within this zone are several occupied dwellings and assorted farm buildings (Photo 1). The contents of the downstream hazard zone were verified by aerial reconnaissance.

e. **Ownership.** We understand the dam is owned by St Joe Lead Co, P O Box 500, Viburnum, Missouri 65566. Correspondence should be addressed to the attention of Mr Jack Krokroskia.

f. **Purpose of dam.** The dam was constructed to impound water pumped from underground lead mines operated in the area by St Joe Lead Co. The water is clarified as the sediment settles out in the reservoir before being released to the natural drainage system.

g. **Design and construction history.** A design drawing prepared by the engineering department of St Joe Lead Co was supplied to the inspection team. This drawing has been included as Appendix C. Other information on the design and construction of the dam was obtained from interviews with Mr John Kennedy and Mr Jack Krokroskia of St Joe Lead Co. The dam was constructed in 1971. The material used in the embankment was borrowed from the hillside adjacent to the left abutment. A keyway was cut approximately 5 ft deep and 30 ft wide from the left end of the dam to the drainage channel for Lick Creek, which ran near the right side of the valley. For the right abutment keyway, a trench was cut approximately 10 ft into the hillside which forms the right abutment. Soil and rock excavated from the dam site and the adjacent borrow area was compacted in the embankment with a sheepsfoot roller. The upstream slope was constructed at 2.5(H) to 1(V) according to the design drawing; the downstream slope was constructed at 2.0(H) to 1(V).

A low-level outlet was placed at the bottom of the fill in the original stream bed for Lick Creek, to carry runoff past the dam site during construction. The outlet was reported plugged at both the upstream and downstream ends following construction.

No other records of the construction and design were available.

h. **Normal operating procedures.** No operating records were available for this dam. The pool elevation is controlled by the elevation of the ungated spillway.

1.3 Pertinent Data

a. **Drainage area.** 1.7 mi^2

b. **Discharge at dam site.**

Maximum known flood at damsite	Unknown
Warm water outlet at pool elevation	N/A (Not applicable)

Diversion tunnel low pool outlet at pool elevation	N/A
Diversion tunnel outlet at pool elevation	N/A
Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation	1900 ft^3/sec
Total spillway capacity at maximum pool elevation	1900 ft^3/sec

c. **Elevations (ft above MSL).**

Top of dam	1048.5
Maximum pool-design surcharge	N/A
Full flood control pool	N/A
Recreation pool	N/A
Spillway crest (gated)	N/A
Upstream portal invert diversion tunnel	N/A
Downstream portal invert diversion tunnel	N/A
Streambed at centerline of dam	1007
Maximum tailwater	Unknown
Toe of dam at maximum section	1010.0

d. **Reservoir.**

Length of maximum pool	2700 ft
Length of recreation pool	N/A
Length of flood control pool	N/A

e. **Storage (acre-feet).**

Recreation pool (spillway crest)	144
Flood control pool	N/A
Design surcharge	N/A
Top of dam	248

f. **Reservoir surface (acres).**

Top of dam	18.2
Maximum pool	18.2

Flood-control pool	N/A
Recreation pool	N/A
Spillway crest	13.5

g. **Dam.**

Type	Compacted earth fill
Length	465 ft
Height	38.5 ft
Top width	12 ft
Side slopes	Upstream 2.5(H) to 1(V) (reported) Downstream 2.0(H) to 1(V)
Zoning	None
Impervious core	None, homogeneous, impervious embankment
Cutoff	Trench; 5 ft - 10 ft deep, 30 ft wide
Grout curtain	None

h. **Diversion and regulating tunnel.**

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating facilities	N/A

i. **Spillway.**

Type	Concrete-lined, irregular shaped. Has vertical metal baffles.
Length of weir	37 ft
Crest elevation	1041.9 ft (MSL)
Gates	None
Downstream channel	Concrete-lined flume
Supplementary outlet	Four 14 in.-diameter pipes with intake upstream of spillway and discharge near end of spillway downstream channel. Maximum discharge capacity approximately 40 ft^3/sec. Approximate inlet elevation 1041.4 ft (MSL).

j. **Regulating outlets.** None

SECTION 2
ENGINEERING DATA

2.1 Design

A design drawing prepared by the St Joseph Lead Co, Engineering Department, was provided to the inspection team. This drawing includes a plan of the dam site, maximum section, profile along the centerline of the dam, keyway in the rock bluff at the west end of dam (right abutment), and section along the low-level outlet pipe. This drawing has been included as Plate C-1, Appendix C.

The findings of the visual inspection appear to agree with the design drawing, with the exception that the spillway width and downstream channel are smaller than presented in the drawing. Also the spillway and dam crest elevations were corrected as shown on the drawing by John Kennedy of St Joe Lead Co. Existing spillway details are shown in Fig 3-C.

2.2 Construction

Information on the construction of the dam was obtained through interviews with Mr Jack Krokroskia and Mr John Kennedy of St Joe Lead Co.

The dam was built in 1971 by St Joe Lead Co. The material used in the construction was excavated from the immediate vicinity of the dam and a borrow area at the left abutment. The embankment was compacted with a sheepsfoot roller. A keyway 5 ft deep and 30 ft wide was cut at the base of the fill, and a trench, maximum 10 ft into the right abutment, was used to key the west end of the dam to the steep rock bluff.

2.3 Operation

No records were available concerning regulation of the pool elevation. Normal pool elevation is controlled by flow through the ungated spillway. At the time of the visual inspection, the pool elevation was approximately 1 ft below the spillway. There was no evidence or record of the dam being overtopped.

2.4 Evaluation

a. **Availability.** The only data available for this dam were the drawing presented on Plate C-1, Appendix C, and the interviews with St Joe Lead Co personnel.

b. **Adequacy.** Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspections of Dams" were not available, which is considered a deficiency. These analyses should be performed by a professional engineer experienced in the design and construction of earth dams. These analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

The available records do not include any strength data on the native soils used in construction of the dam, or any compaction tests made during construction. Consequently, the adequacy of the embankment design cannot be assessed. Our comments concerning the adequacy of the spillway are discussed in *Section 5 of this report.*

c. **Validity.** There is not reason to question the validity of the information supplied in the drawings or interviews. The information was not in conflict with the conditions observed during our inspection.

2.5 Project Geology

The dam site is on the western flank of the Ozark structural dome. Dip of the bedrock is relatively flat. The regional dip is to the west.

The area is mapped on the Geologic Map of Missouri (1979) as underlain by Cambrian age Potosi and Eminence Dolomite formations. The site is near the top of this sequence of dolomite and is likely underlain by the Eminence Dolomite. Both the Potosi and Eminence formations are typically light gray in color, medium- to fine-grained dolomite. The Eminence Dolomite contains less chert and quartz druse than does the Potosi Dolomite. Large springs and solution caverns are known to be present in the Eminence Dolomite in parts of Missouri. A spring was noted at the right abutment and several springs and a cave are mapped within several miles of

the site. This suggests some potential for solution activity in the bedrock at the site. It is suggested that this condition be more thoroughly investigated if this dam is enlarged and raised in the future, as is reportedly planned.

Two soils were noted at the dam site. On the flatter slopes of the hillside at the left abutment, a shallow, 2 to 3 ft thick, yellow to tan, silty soil (ML) was noted. This is probably a recent loess deposit. Below this and on the steeper slopes in the area is a stony to sandy, red-brown to light-brown clay (CL), apparently a residual soil developed by weathering of the carbonate bedrock. The stony fraction includes blocks of weathered rock ranging from several feet in diameter to sand and silt. The soils in the dam site area are mapped on the General Soils Map of Missouri (1979) as Captina-Clarksville-Doniphan Soil Association.

Two faults are mapped in the area on the Structural Features Map of Missouri (1971). The Black Fault is located approximately 10 mi northeast of the site. The fault is mapped as northeast side up, trends northwest-southeast, and is 16 mi in length. The Ellington Fault is mapped 12 mi southwest of the site, has a mapped length of 22 mi, and like the Black Fault trends northwest-south with the northeast side up. Both faults are within Paleozoic bedrock formations and are likely Paleozoic in age. The area is not seismically active and these faults are not considered to pose an unusual hazard to this dam.

The dam is located approximately 100 mi northwest of the line of epicenters for the very large New Madrid earthquakes which occurred in 1811 and 1812. A recurrence of an earthquake of the magnitude of the New Madrid events could possibly cause damage at the dam, but a study of this aspect of risk was beyond the scope of this Phase I study.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. **General.** A visual inspection of Brushy Creek Mine Water Clarification Dam was made on 22 October 1980. Mr John Kennedy of St Joe Lead Co was present for a portion of the inspection. The inspection indicated the dam embankment is in generally good condition.

b. **Dam.** The dam is an earth fill dam constructed of rocky to silty clay (CL) (Photo 2), apparently excavated out of the hillsides adjacent to the dam. Rock in the embankment ranges from several feet in diameter to small gravel. The silty clay appears to be a residual soil typically developed as a result of weathering of the carbonate bedrock in the area. This embankment material is considered to have a moderate susceptibility to erosion in the event of overtopping. No evidence or record of past overtopping was noted during the visual inspection.

The downstream slope of the dam is relatively steep, approximately 2(H) to 1(V), and is vegetated with grass and small bushes (Photo 3). This vegetation provides some erosion protection. The upstream face of the dam has a slope of 2 to 2.5(H) to 1(V) from the crest to the lake level, and is also vegetated with grass and brush. There is no riprap or other erosion protection on the upstream face of the dam. However, the rocky nature of the embankment materials (as well as the present condition of the slope) suggest the potential for wave erosion is relatively low.

The vertical and horizontal alignment of the dam crest appears undisrupted (Photo 4). There was no evidence of detrimental settlement, sinkhole development or animal burrows on the dam. Some minor rill erosion has occurred on the downstream face. One area near the maximum section (about 2/3 of the way up the downstream face of the dam) appears to have slumped (Photo 5). The localized slump scarps were discontinuous and those that were observed

measured less than 6 in. The area was well vegetated and did not appear to be a recent or deep-seated deformation feature.

A construction drain exits at the toe of the dam near the maximum section (Photo 6). The drain consists of a 24-in. diameter iron pipe with a plate attached to the downstream end. No control mechanism was noted on this outlet. The drain was reported to be plugged at the upstream end; it was observed to be plugged with a steel plate and a rubber seal at the exposed downstream end.

A pool of water was present at the toe of the dam (Photo 7) at the time of inspection. It could not be determined whether this pool is the result of leakage from the construction drain, from seepage at the toe of the dam, or from spring discharge. A flowing spring was identified on the right abutment about 25 ft above the valley floor (Photo 8). This spring was flowing an estimated 10 gal/min at the time of the inspection. The lack of aquatic vegetation or a well developed discharge channel suggest this may be a recent feature and could be water seeping from the reservoir. However, grading for the dam construction could have disrupted the existing vegetation and topography of a prior existing spring. This spring flows into the pond at the toe of the dam. It did not appear to be transporting any soil at the time of the inspection.

c. **Appurtenant structures.**

1. Spillway. The spillway for this dam is located at the left abutment (Photo 9). The spillway is concrete lined and irregular in shape. An iron frame, or baffle, is in place in a portion of the spillway, apparently where gates could be installed to partially control the lake level. No gates or other spillway control features were present at the time of the visual inspection. The iron frame does present some potential for collecting debris and obstructing the spillway during flood flows. The concrete lining indicates there is little potential for erosion of the spillway during flooding.

Directly upstream of the spillway crest, there are four 14-in. diameter pipes encased in a concrete inlet structure equipped with a trash rack. After a short vertical inlet, these pipes continue horizontally parallel to the lined

downstream discharge channel. The pipe outlet is near the end of the discharge channel, approximately 370 ft downstream.

2. Low-level outlet. A construction drain is located at the base of the dam in the channel of the original streambed. This drain consists of a 24-in. diameter iron pipe with a rubber seal and steel plate clamped to the downstream end. The downstream end was partly submerged in the pool at the toe of the dam and it could not be determined if the pipe was leaking. No control mechanism other than the plate at the end of the pipe was noted for this drain. The pipe was reported to also be plugged at the upstream end.

d. **Reservoir area.** The reservoir is used to retain water pumped from the underground workings of the St Joe Lead Co Brushy Creek Mine. The area surrounding the reservoir is densely wooded and little sediment appears to be transported from the surrounding hillsides into the reservoir. Some sediment is introduced at the upstream end of the reservoir where the water pumped from the mine enters the lake. This, however, appears to be a relatively small amount of material. No signs of unstable slopes were noted in the area surrounding the reservoir.

There are tentative plans to convert this impoundment to a tailings disposal site in the future, according to Mr Kennedy. This will significantly affect the potential storage in the reservoir. However, our inspection and this report deal only with the conditions at the time of the visual inspection.

e. **Downstream channel.** The downstream discharge channel below the spillway is a concrete-lined flume along the left side of the valley (as the observer faces downstream). It extends approximately 370 ft downstream of the spillway and ends at a drop-off of about 10 ft. Substantial erosion has occurred at the downstream end, and has partially undermined the end of the discharge channel lining. The unlined channel continues from this drop-off to the original channel of Lick Creek.

3.2 Evaluation

The visual inspection indicates the dam embankment is in generally good condition. No evidence of disruption of the vertical or horizontal alignment of the dam crest was noted. The rocky to silty clay used in the dam construction appears to have a moderate erosion potential. Grass and brush vegetation on the embankment offer some erosion protection.

A small area of slumping may be present near the maximum section on the downstream face, but the small scarp is vegetated and indistinct and appears to be an old feature.

A spring was noted on the right abutment, flowing about 10 gal/min. This spring could be seepage from the reservoir through the abutment or a natural feature. It did not appear to be transporting any soil and is not considered to pose a hazard to the dam at this time. There is some indication that the spring may be relatively young (lack of erosion and vegetation). It is suggested that the spring area be re-inspected several times at reasonably frequent intervals to ascertain that the volume of seepage is not increasing.

The spillway and upper reaches of the discharge channel are concrete-lined and there appears to be little potential for erosion within the lined portion of the channel. Undercutting by erosion could affect the downstream end of the discharge channel lining. There is some potential for obstruction of the spillway due to debris becoming lodged in the iron baffle at the spillway.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

The inspection did not identify any operational procedures at this dam. There were no facilities identified which required operation. The reservoir pool elevation is controlled by the crest elevation of the spillway.

4.2 Maintenance of the Dam

No records of maintenance on this dam were available. The concrete-lined discharge channel, spillway, and embankment all appear to be in good condition. Some small trees are just becoming established on the embankment. These should be removed before they become large enough to pose a potential hazard to the dam.

4.3 Maintenance of Operating Facilities

No facilities requiring operation were identified at this dam. The pipe beneath the dam was described as a construction bypass to allow the dam to be constructed without impounding water. Following completion of the dam, it was reportedly closed at both ends. It was observed to be closed at the downstream end.

4.4 Description of Any Warning System in Effect

The visual inspection did not identify any warning system at this dam.

4.5 Evaluation

There are no operational procedures or records of maintenance at this dam. This is considered a deficiency. However, the dam and appurtenant facilities appear to be in generally good repair. A program of scheduled inspections and maintenance is recommended.

The feasibility of a practical warning system should be evaluated to alert the downstream residents in the event potentially hazardous conditions develop at the dam during periods of heavy precipitation.

SECTION 5
HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. **Design data.** No hydrologic or hydraulic design data were available for evaluation of this dam or reservoir; however, dimensions and elevations of the dam were obtained from drawing No. 71X42-2 provided by St Joseph Lead Co, Bonneterre, Missouri (Plate C-1, Appendix C), or measured during the field inspection. Other relevant data were estimated from topographic mapping. The maps used in the analyses were the USGS Greeley and Oates 7.5-minute quadrangle maps (1967).

b. **Experience data.** No recorded rainfall, runoff, discharge, or pool stage historical data were found for this reservoir.

c. **Visual inspection.**

1. Watershed. The watershed is natural woods forested with mixed hardwoods and softwoods. The area of the reservoir is approximately 1.5 percent of the total drainage area of 1.7 mi^2.

2. Reservoir. The reservoir and dam are best described by the maps and photographs enclosed herewith. The reservoir is used for clarification of mine water.

3. Spillway. The spillway consists of an uncontrolled, relatively steep, concrete-lined open channel. The entrance elevation is 1041.9 ft (MSL). Four 14 in.-diameter pipes are also present as described in Section 3.1c of this report. Their discharge capacity is considered insignificant relative to the spillway discharge capacity. If the pipes were flowing full, they would discharge approximately 40 ft^3/sec, compared to a total discharge of 1900 ft^3/sec at overtopping. Discharge through these pipes was not included in the overtopping analysis. The width of the spillway indicates that at maximum discharge, the downstream channel will be overtopped.

4. Seepage. The magnitude of seepage through this dam is very small and not hydraulically significant to the overtopping potential.

d. **Overtopping potential.** One of the important considerations in the evaluation of Brushy Creek Mine Water Clarification Dam is the assessment of the potential for overtopping and possible consequent failure by erosion of the embankment. The dam crest is considered to be level. The four 14-in. diameter spillway pipes were assumed to be inoperative for this analysis.

Hydrologic analysis of this dam for the 1 and 10 percent probability-of-occurrence and Probable Maximum Floods (PMF) were all based on initial water surface elevations equal to the main spillway crest elevation. The results of the analyses indicate that a flood of greater than 25 percent of the PMF will overtop the dam. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The analyses also indicate that the spillway will pass the 1 percent probability-of-occurrence flood (100-year flood) without overtopping the dam. The total spillway capacity at maximum pool elevation (top of dam) is approximately 1900 ft^3/sec.

The following overtopping analysis data for the various precipitation events were computed for the dam, assuming no erosion of the dam crest or spillway:

Precipitation Event	Maximum Reservoir Water Surface Elevation, ft (MSL)	Maximum Depth Over Dam, ft	Maximum Outflow, ft^3/sec	Duration of Overtopping, hrs
1% Prob	1047.8	0	1600	0
25% PMF	1048.3	0	1800	0
50% PMF	1049.5	1.0	3900	3.0
100% PMF	1050.6	2.1	7800	5.7

It is recommended that a spillway design flood of at least 50 percent of the PMF be used for this small dam provided that the spillway design recommendations incorporate some of the measures discussed below. This recommendation is based on the broad downstream valley of Bills Creek, and the relatively large distance from the dam to the nearest occupied dwellings.

It should be noted, however, that with the present spillway configuration the depth of overtopping at 100 percent of the PMF will reach 2.1 ft and the dam will be overtopped for almost 6 hours. During this period, significant erosion would very likely take place and could lead to an effective breach of the dam.

It is suggested, therefore, that when the recommended spillway design study is made, particular attention be directed toward the evaluation of the remaining erosion hazard in the event of a 100 percent PMF storm. If the selected spillway capacity re-design approach includes raising of the existing dam crest, consideration may be given to incorporating some erosion-control measures with the new dam crest materials (e.g., soil-cement). Whatever design approach is chosen, one of the study objectives should be to minimize the likelihood of dam embankment erosion for storm events exceeding 50 percent of the PMF.

The input data and output summaries for the hydrologic analyses are presented in Appendix B.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. **Visual inspection.** The visual inspection of the Brushy Creek Mine Water Clarification Dam revealed no evidence of disruption of the vertical or horizontal alignment of the dam crest. One area near the maximum section, about 2/3 of the way up the downstream face of the dam, appeared to have slumped in the past. However, the area was well vegetated and the deformation did not appear to be a recent or deep-seated feature. There was no evidence of detrimental settlement, sinkhole development, or cracking of the dam embankment.

The potentially new spring on the right abutment should be periodically re-inspected to ascertain that the volume of seepage is not increasing, and that the flow is not carrying soil.

b. **Design and construction data.** A design drawing was provided by St Joe Lead Co. This drawing is included as Plate C-1, Appendix C. Other information on the design and construction of the dam was obtained through interviews with St Joe Lead Co personnel.

Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available. This is considered a deficiency.

c. **Operating records.** No operating records or water level records are maintained for this facility.

d. **Post construction changes.** No post construction changes were noted or reported for the dam. The concrete lining of the discharge channel appeared to be a recent feature, probably constructed in the last 1 to 2 years.

e. **Seismic stability.** The dam is located in Seismic Zone 2, to which the guidelines assign a moderate damage potential. In view of the rocky soil used in the dam construction, liquefaction is unlikely during a moderate seismic event. However, since soil property data or static stability analyses are not available for review, the seismic stability cannot be properly evaluated.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

a. **Safety.** On the basis of the visual inspection, the Brushy Creek Mine Water Clarification Dam embankment is judged to be in generally good condition. However, the hydraulic and hydrologic analyses indicate the spillway will pass only about 25 percent of the PMF, which is considered a deficiency under the guidelines. The embankment material is considered moderately resistant to erosion, but in the event of prolonged overtopping with high flow velocities, sufficient erosion could occur to result in failure of the dam.

Seepage and stability analyses comparable to the requirements in the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is also considered a deficiency.

b. **Adequacy of information.** The visual inspection and an engineering drawing supplied by St Joe Lead Co provided a reasonable base of information for the conclusions and recommendations in this Phase I report.

The lack of seepage and stability analyses as recommended in the guidelines precludes an evaluation of the structural and seismic stability of the dam. The lack of these analyses is considered a deficiency which should be rectified.

c. **Urgency.** The deficiencies described in this report could affect the risk of failure of this dam. It is suggested that the recommendations in Section 7.2b on the spillway capacity re-design be implemented without undue delay to prevent the development of hazardous conditions at the dam. Other recommendations presented in Section 7.2b and 7.2c should be implemented as soon as practical.

d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspection of Dams," the subject investigation is a minimum study.

This study revealed that additional in-depth investigations are needed to complete the assessment of the safety of the dam. These investigations which should be performed without undue delay are described in Section 7.2b. It is our understanding from discussions with the St Louis District that any additional investigations are the responsibility of the owner.

7.2 Remedial Measures

a. **Alternatives.** There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these general options are:

1. Remove the dam, or breach it to prevent the storage of water;

2. Increase the height of the dam and/or spillway size to pass the spillway design flood without overtopping the dam;

3. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy;

4. Provide a highly reliable flood warning system (generally does not prevent damage, but diminishes the chances for loss of life).

b. **Recommendations.** The following specific remedial measures and additional studies are recommended for this dam, to be undertaken without undue delay.

1. Prepare a more detailed hydraulic/hydrologic analysis and design a spillway system capable of passing at least 50 percent of the Probable Maximum Flood, without overtopping the dam. The recommended spillway design flood is based on the broad downstream valley of Bills Creek and the relatively large distance to the nearest occupied dwellings. This design study should include an evaluation of the risk of embankment erosion for storms greater than 50 percent of the PMF.

2. Consider removal of the metal baffles from the spillway section to prevent development of obstructions that could reduce the spillway capacity.

The following measures should be undertaken as soon as practical.

3. Prepare seepage and stability analyses for the dam in accordance with the "Recommended Guidelines for Safety Inspection of Dams."

4. Remove small trees from the embankment before they become large enough to pose a potential hazard to the dam.

5. Evaluate available options for an effective and practical warning system to alert downstream residents should potentially hazardous conditions develop at the dam.

It is recommended that these remedial measures and studies be done by, or under the guidance of an engineer experienced in the design and construction of earth dams.

c. **O and M procedures.** A program of periodic inspections and maintenance should be implemented for the dam as soon as practical. This program should include but not be limited to the following items.

1. Inspect the embankment to identify any signs of slope instability such as slumping and cracking.

2. Inspect the abutments, embankment, and construction drain for signs of seepage or corrosion. Inspection of springs and seeps should include estimates of the volume of seepage and note made of any turbidity (soil) in the seepage water. Particular attention should be directed to the spring on the right abutment described in this report.

3. Inspect the spillway area and downstream end of the discharge channel to identify any significant erosion following heavy precipitation.

4. Prepare records of recommended and performed maintenance on the facilities.

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Allgood, F. P., and Persinger, I. D., 1979, "Missouri General Soil Map and Soil Association Descriptions," US Department of Agriculture, Soil Conservation Service and Missouri Agricultural Experiment Station.

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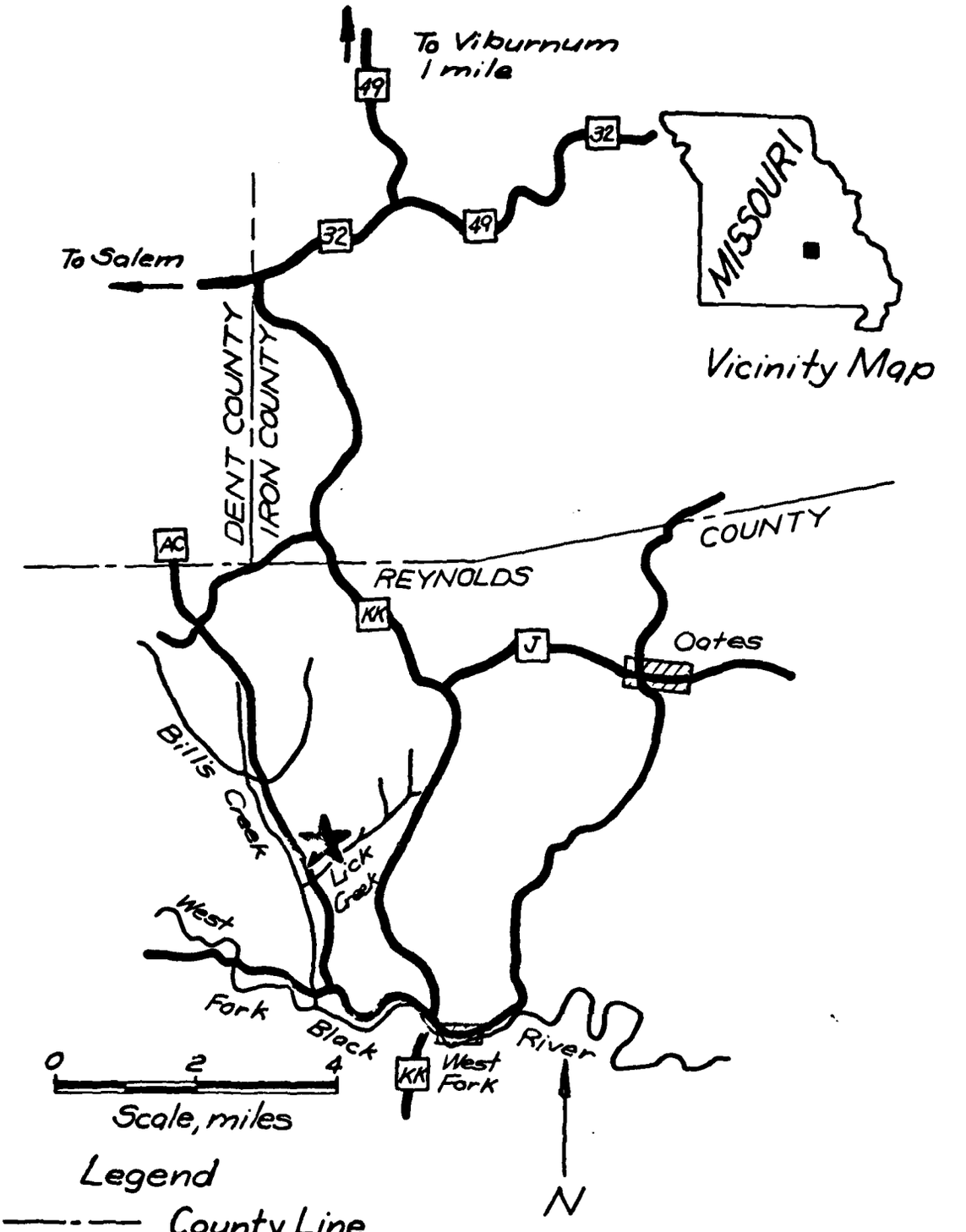
McCracken, M. H., 1971, Structural Features Map of Missouri: Missouri Geological Survey, Scale 1:500,000.

Missouri Geological Survey, 1979, Geologic Map of Missouri: Missouri Geological Survey, Scale 1:500,000.

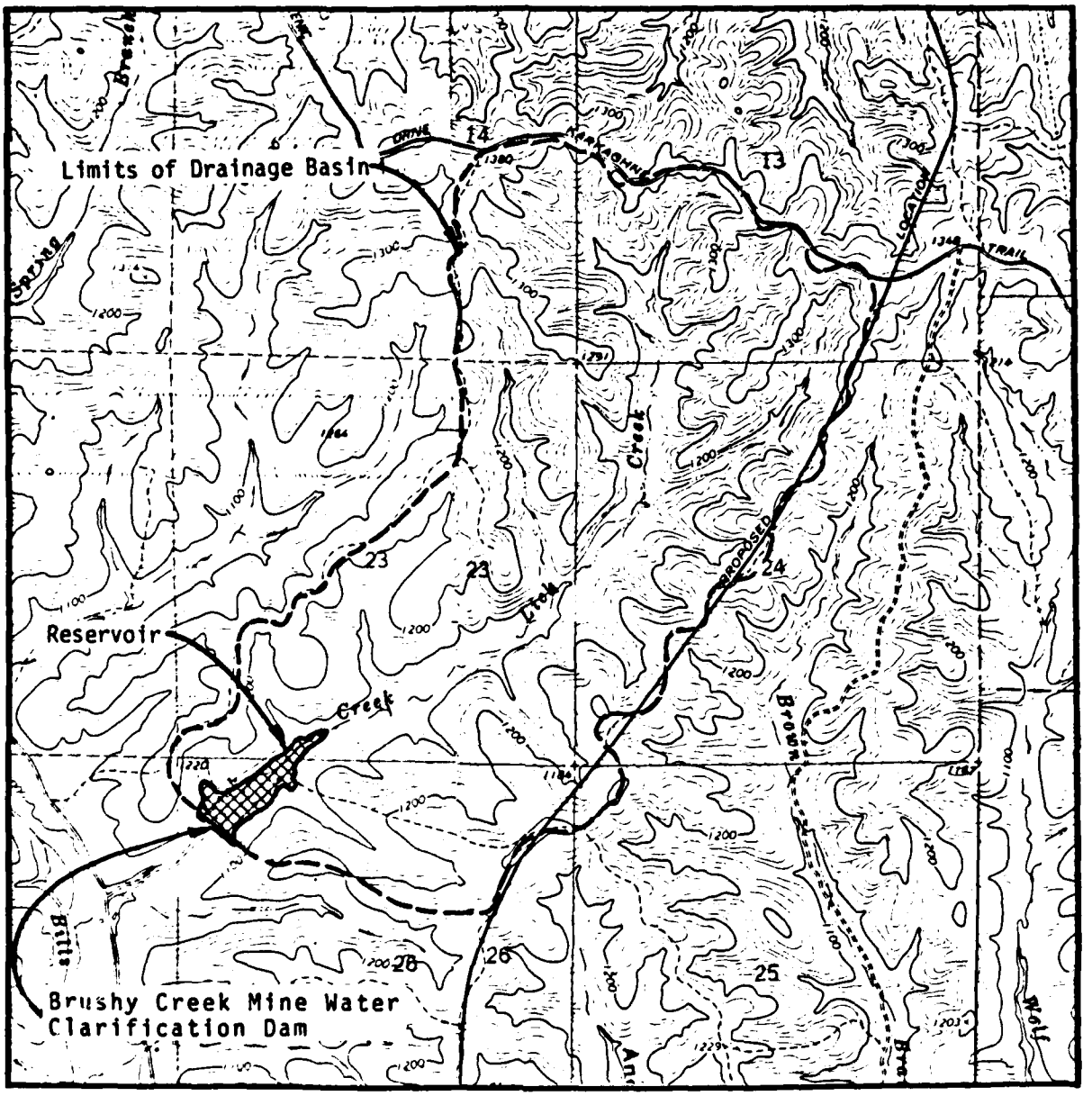
St Louis District, US Army Corps of Engineers, 1979, "Hydrologic/Hydraulic Standards, Phase I Safety Inspection of Non-Federal Dams."

US Department of Agriculture, Soil Conservation Service, 1971, Hydrology: National Engineering Handbook, Section 4.

US Department of Commerce, US Weather Bureau, 1956, "Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours," Hydrometeorological Report No. 33.



SITE LOCATION MAP	
BRUSHY CREEK MINE WATER CLARIFICATION DAM	
MO 30330	Fig. 1



N

0 2000 4000

Scale, feet

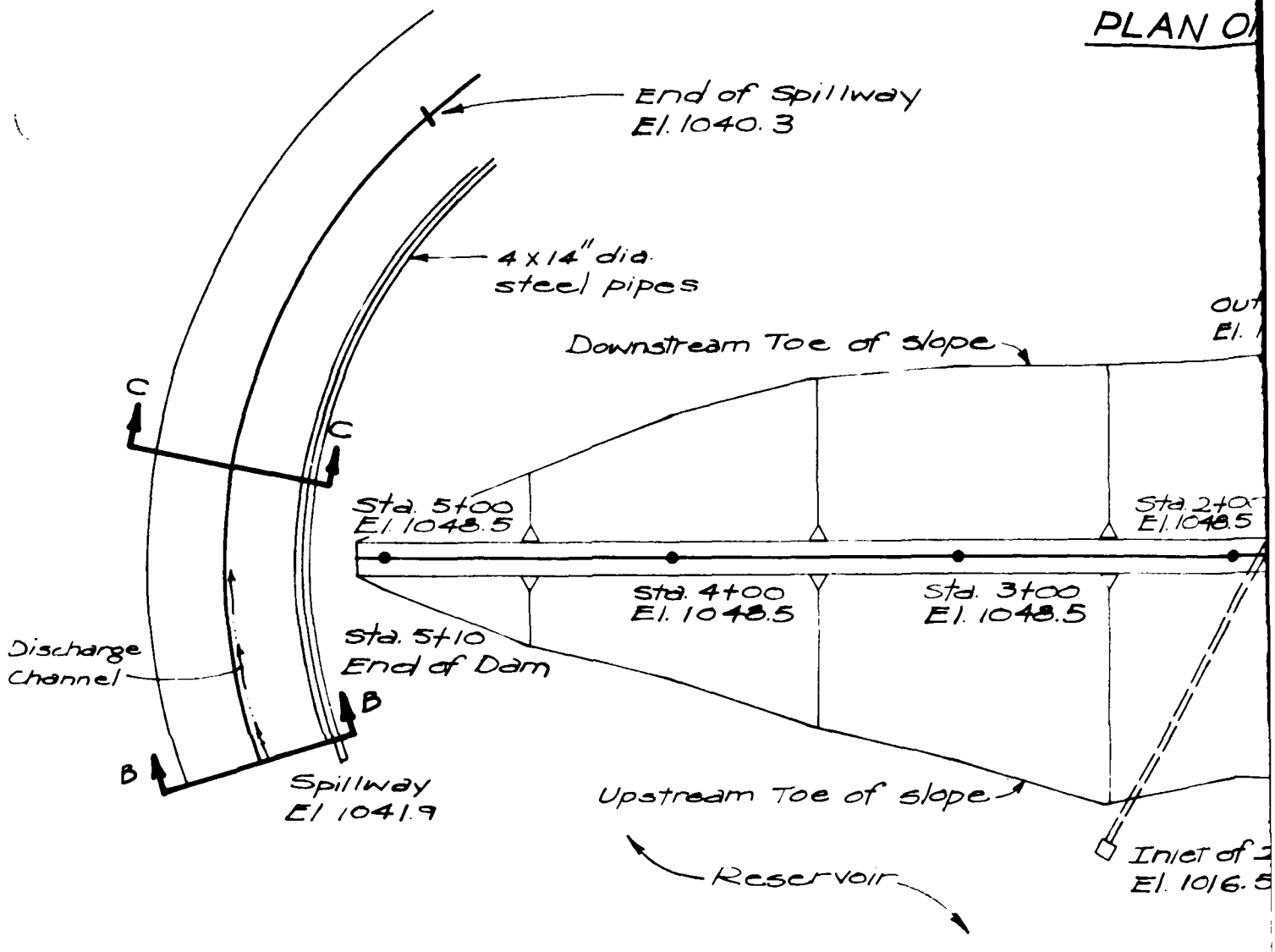
Notes:
1. Topography from USGS Greeley(1967) and Oates(1967) 7.5-minute quadrangle maps

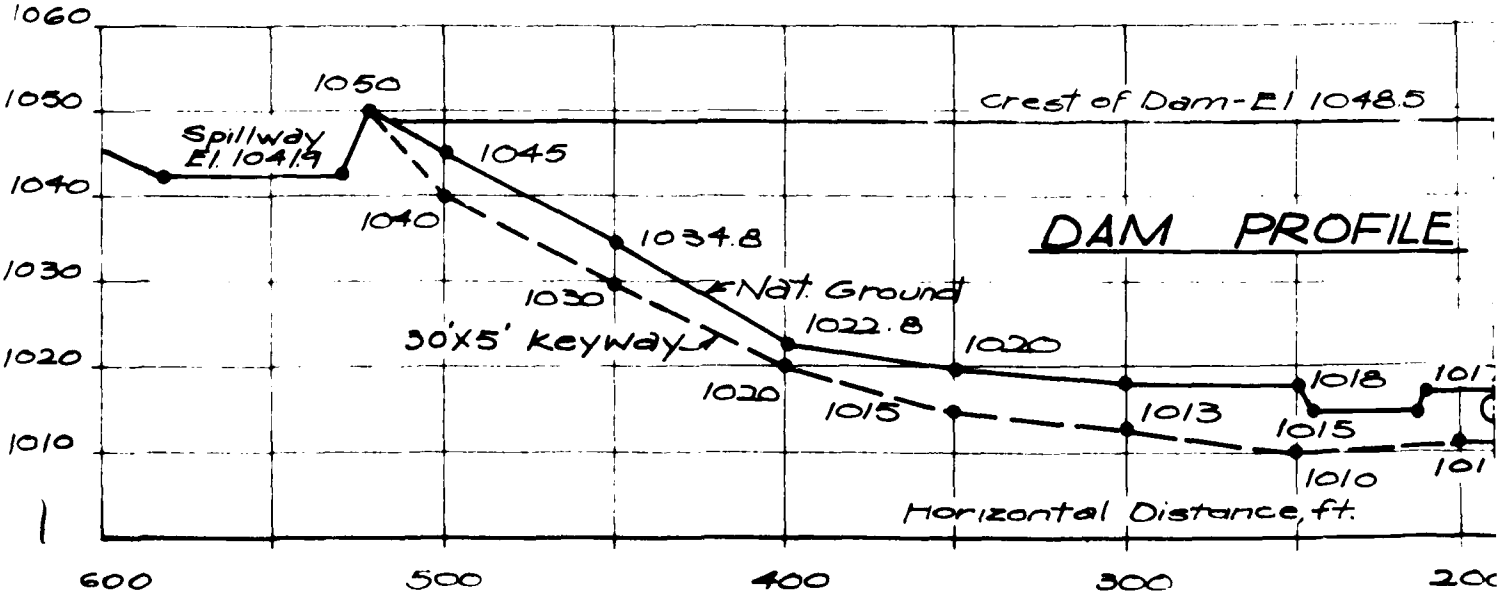
DRAINAGE BASIN AND SITE TOPOGRAPHY

BRUSHY CREEK MINE WATER CLARIFICATION DAM

MO 30330 | Fig. 2

PLAN O


End of Spillway
El. 1040.3
4 x 14" dia.
steel pipes
Downstream Toe of slope
C
C
Sta. 5+00
El. 1048.5
Sta. 4+00
El. 1048.5
Sta. 3+00
El. 1048.5
Sta. 5+10
End of Dam
Discharge
Channel
B
B
Spillway
El 1041.9
Upstream Toe of slope
Reservoir

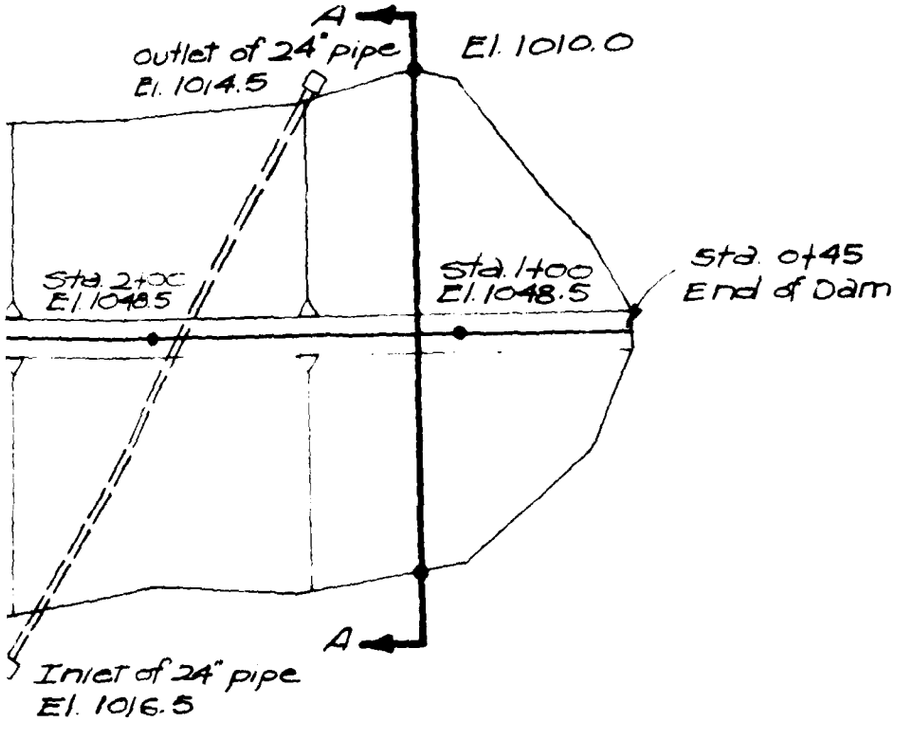

1060
1050
1040
1030
1020
1010
1050
Spillway
El. 1041.9
1045
1040
1034.8
1030
Nat. Ground
1022.8
1020
30'X5' keyway
1020
1015
1013
1018
1015
1010
Crest of Dam-El 1048.5
DAM PROFILE
Horizontal Distance, ft.
600
500
400
300

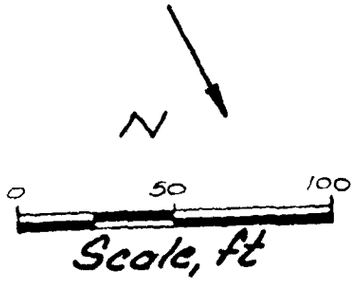
PLAN OF DAM

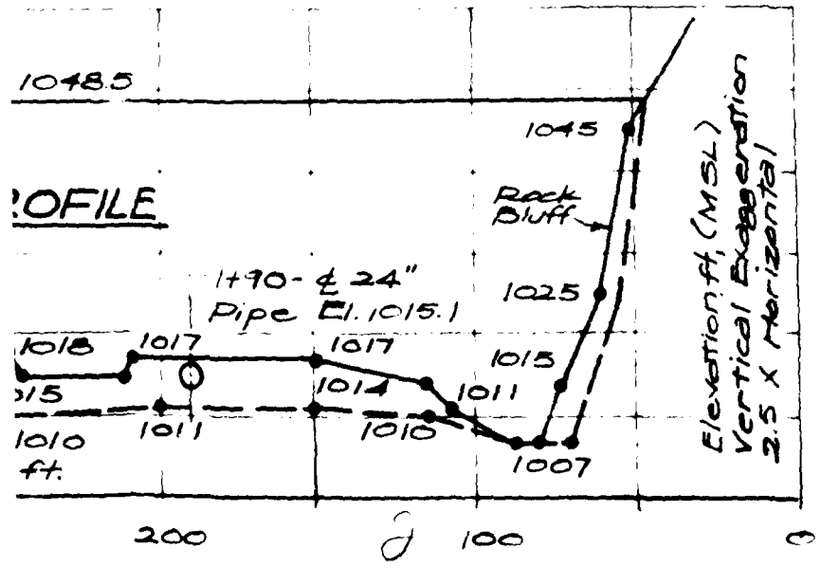
Notes

1 Surveyed 9 Sept. 1971 by St Joseph Lead Co., Bonne Terre, Mo

2 Natural ground and upstream slope from St Joseph Lead Co. drawing 71x42-2 dated 3 Sept. 1971



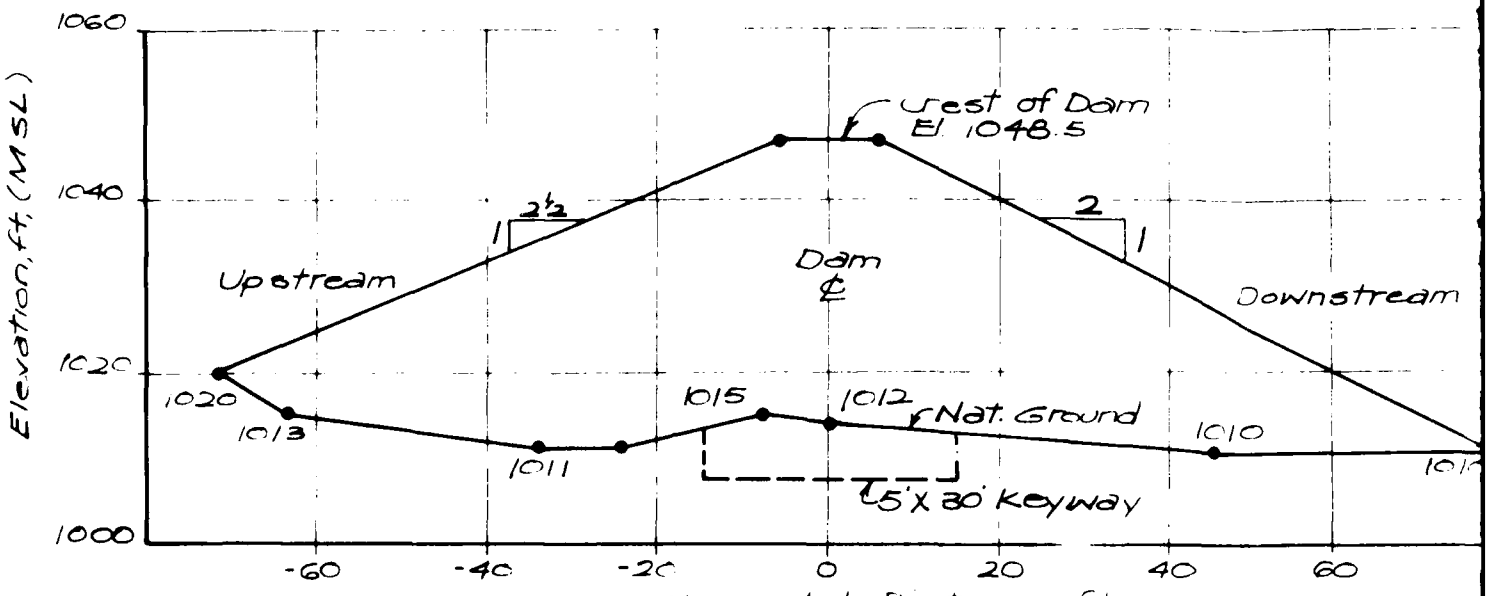




PLAN AND PROFILE OF DAM

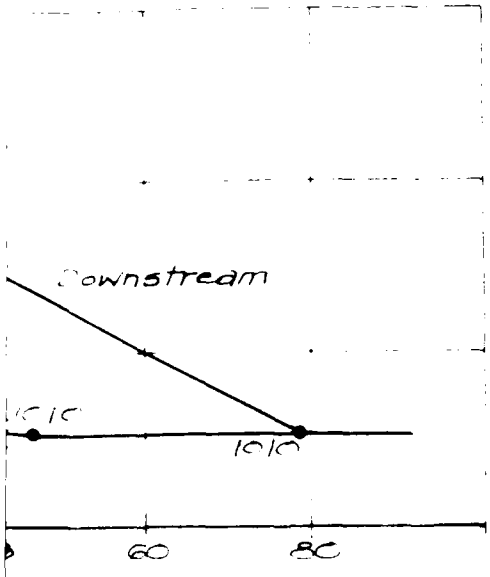
BRUSHY CREEK MINE WATER CLARIFICATION DAM

MO 30330 | Fig. 3-A



SECTION A-A

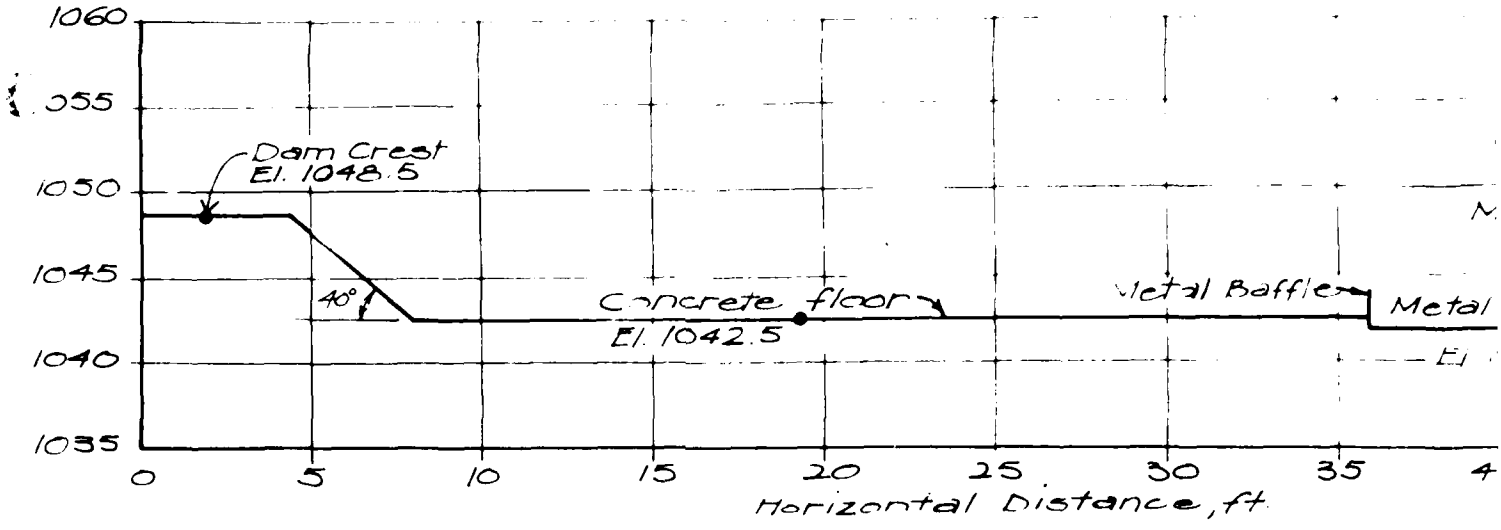
Maximum Section of Dam



Note

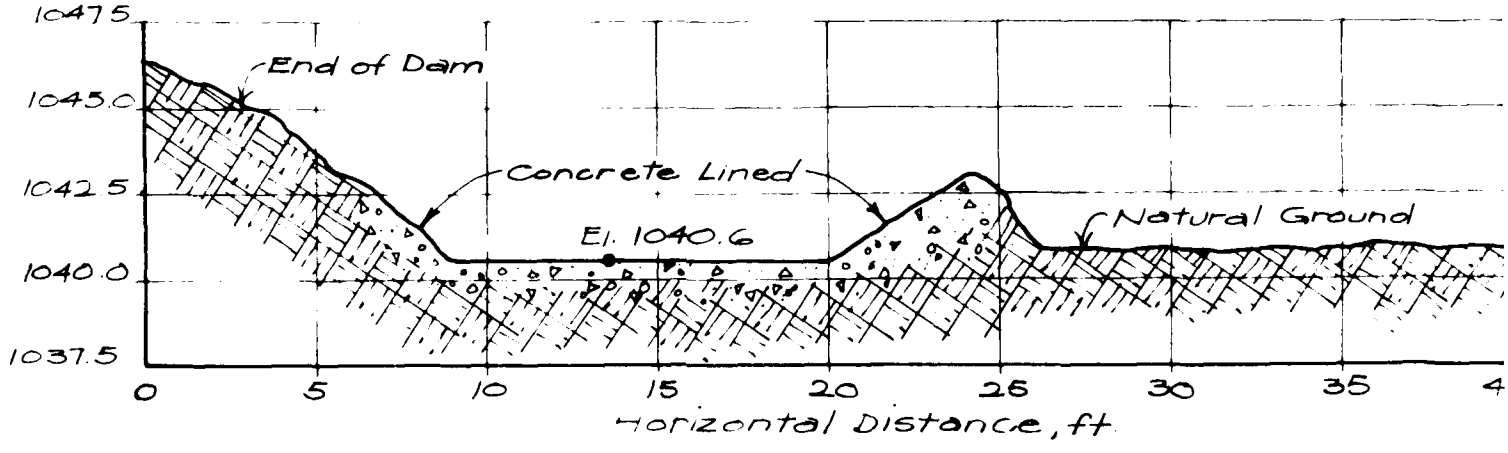
Natural ground and upstream slope from St Joseph Lead Co drawing 71X42-2 dated 4 Mar 1971

DAM CROSS SECTION	
BRUSHY CREEK MINE WATER CLARIFICATION DAM	
MO 30330	Fig. 3-B



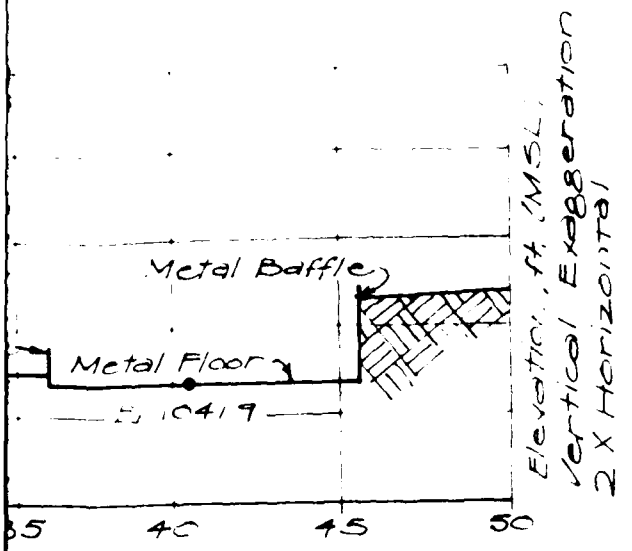
SECTION B-B

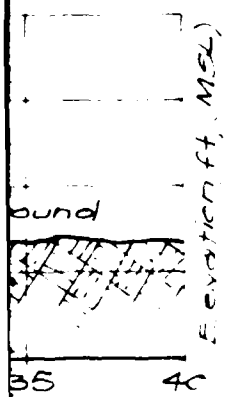
Spillway Section



SECTION C-C

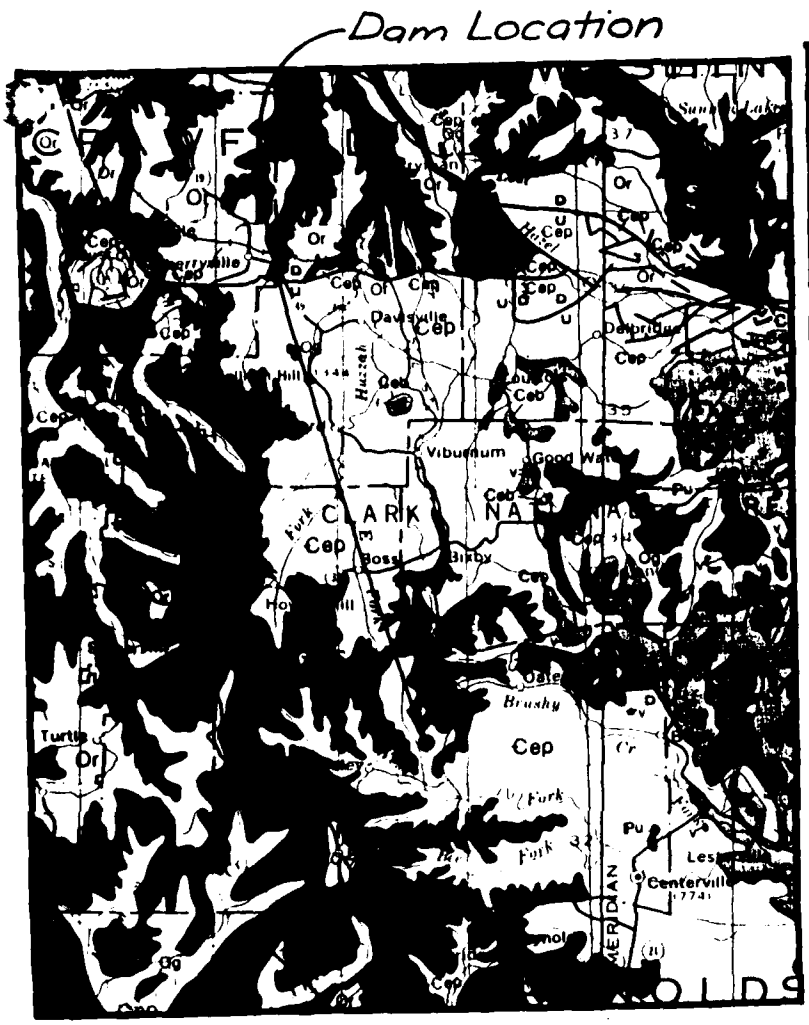
Downstream Channel





Note
Channel Bottom is not smooth, but rough concrete with stones ranging from 3/16" to ≈ 1" embedded in concrete.

SPILLWAY AND DISCHARGE CHANNEL PROFILES	
BRUSHY CREEK MINE WATER CLARIFICATION DAM	
MO 30330	Fig. 3-C



Legend

- Ojc — *Smithville Formation*, Powell Dolomite, Cotter Dolomite, Jefferson City Dolomite
- Or — Roubidoux Formation
- Gasconade Dolomite
  - Gunter Sandstone Member
- Cep — Eminence Dolomite
- Potosi Dolomite
- Derby-Doerun Dolomite
- Davis Formation
- Bonneterre Formation
  - Whetstone Creek Member
  - Sullivan Siltstone Member
- Reagan Sandstone (subsurface, western Missouri)
- Lamotte Sandstone
- Diabase (dikes and sills)
- St. Francois Mountains Intrusive Suite
- St. Francois Mountains Volcanic Supergroup

REGIONAL GEOLOGIC MAP

BRUSHY CREEK MINE WATER CLARIFICATION DAM

MO 30330 | Fig. 4

APPENDIX A

Photographs

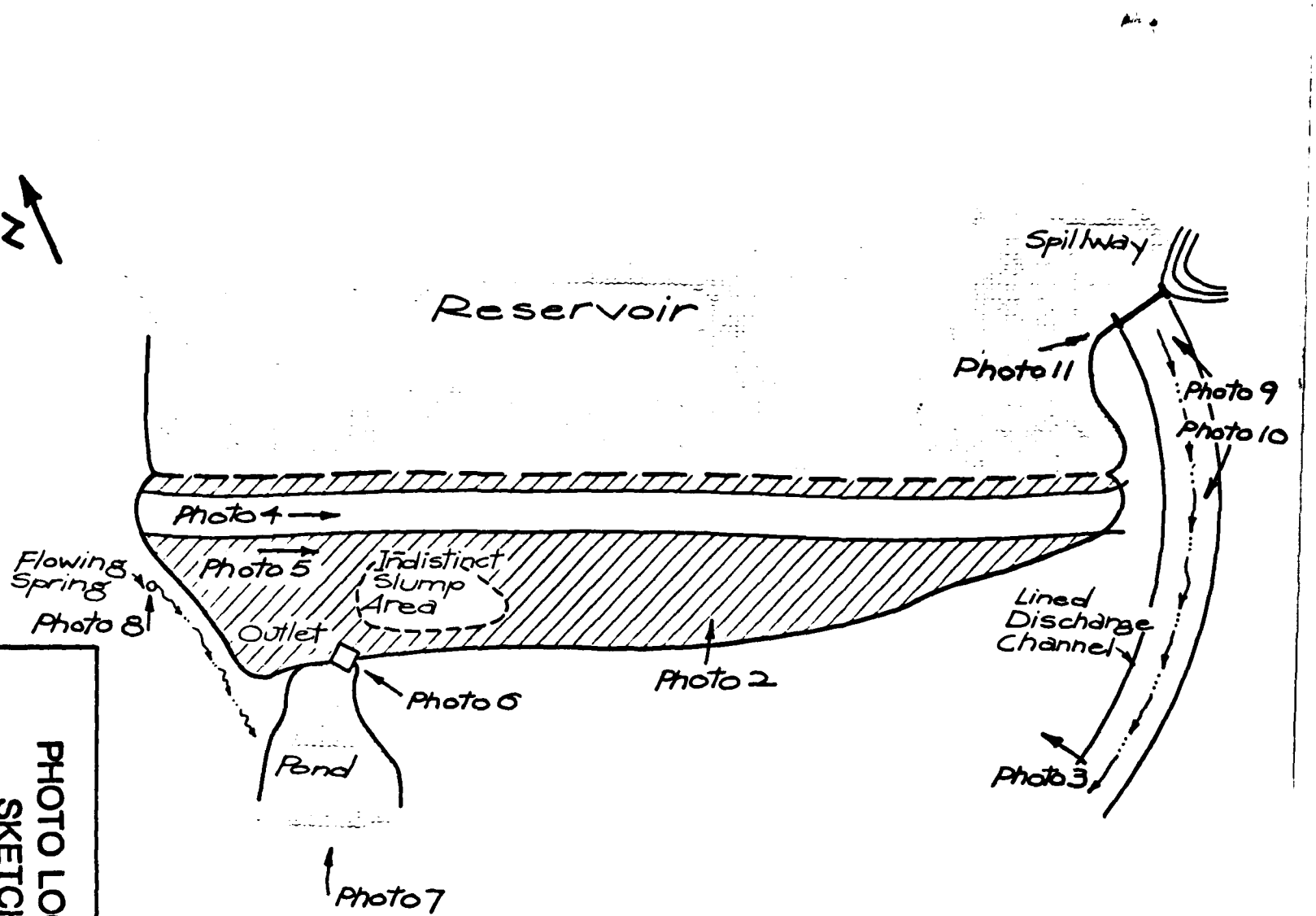


PHOTO LOCATION SKETCH

BRUSHY CREEK MINE WATER CLARIFICATION DAM

MO 30330

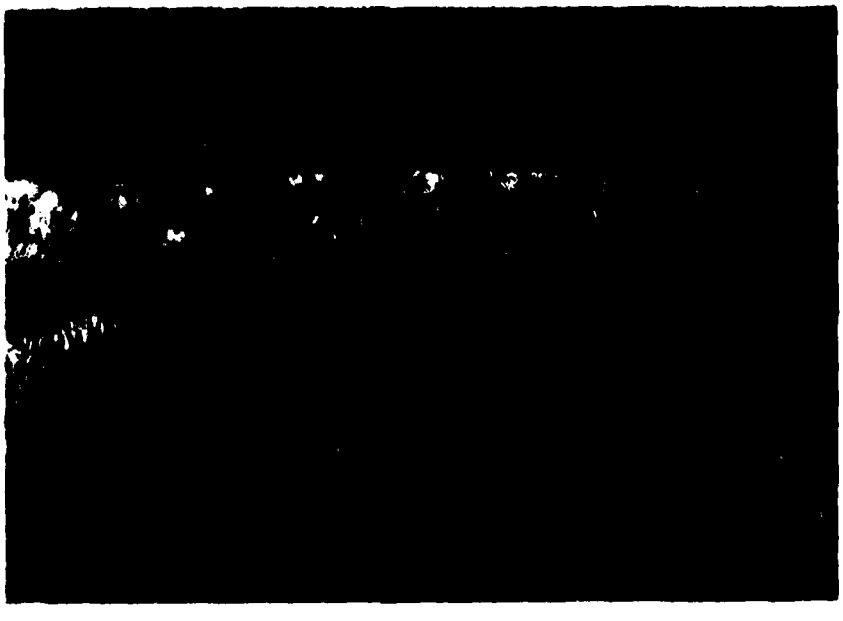
Fig. A-1

Photo 1
Aerial View of Downstream Hazard Zone

1. Typical downstream hazard zone contents. Along Bills Creek near confluence with the Black River.

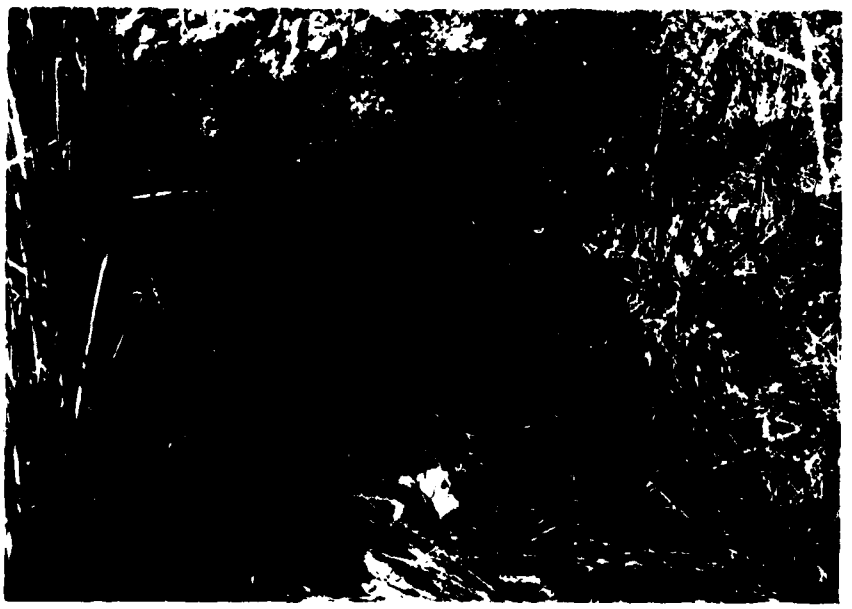
2. Stony soil and weathered rock used in dam construction, exposed on downstream face of dam. Looking upstream from toe of dam.

3. View of downstream face of dam showing minor rilling erosion and grass cover. Looking northwest from discharge channel.



4. View along crest of dam looking toward left abutment. Borrow area for construction in the background. Reservoir is to the left. Looking southeast along dam crest.

5. Area of minor slump on downstream face of dam. Head of slump is near small tree in the foreground, and extends to observer in the distance. Looking southeast.



6. Downstream end of construction drain at toe of maximum section. Sealed by steel plate and rubber seal.

7. Pond at toe of maximum section. Construction drain is in weeds at toe of dam. Looking northeast (upstream).

8. Flowing spring at right abutment. Flow estimated at approximately 10 gpm at time of inspection.

9. Spillway at left end of dam. Note iron frame which could cause obstructions. Looking northwest.

10. Discharge channel at left abutment. Looking southwest (downstream).

11. Inlet to four 14-in. diameter supplementary outlet pipes. The pipes are visible to the right of the spillway discharge channel in Photo 10.

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

APPENDIX B
Hydraulic/Hydrologic Data and Analyses

B.1. Procedures

a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.

b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956).

c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (SCS, 1971, Hydrology: National Engineering Handbook, Section 4) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi^2, and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{\ell^{0.8}\,(s+1)^{0.7}}{1900\,Y^{0.5}} \qquad \text{(Equation 15-4)}$$

where: L = lag in hours 1.2 hours
ℓ = hydraulic length of the watershed in feet = 10,600
$s = \frac{1000}{CN} - 10 = 3.5$

CN = hydrologic soil curve number as indicated in Section B2e
Y = average watershed land slope in percent = 4.5

This empirical relationship accounts for the soil cover, average watershed slope, and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_c = \frac{L}{0.6} \qquad \text{(Equation 15-3)}$$

where: T_c = time of concentration in hours

L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was estimated utilizing the following relationship:

$$\Delta D = 0.133 T_C \qquad \text{(Equation 16-12)}$$

where: ΔD = duration of unit excess rainfall
T_C = time of concentration in hours.

The final interval was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, a time interval of 15 minutes was used.

d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS curve number method. The curve numbers were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) degree of development, (d) vegetative cover, and (e) present land usage in the watershed.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

(1) 1 and 10 percent probability events - spillway crest elevation, 1041.9 ft;

(2) Probable Maximum Storm - spillway crest elevation, 1041.9 ft.

f. Spillway Rating Curve. The HEC-2 computer program was used to compute the spillway rating curve using the spillway cross section and assuming critical depth over the spillway.

Because the 14-in. outlet pipes are of small diameter, discharge through these pipes was not considered significant relative to the spillway discharge capacity.

B.2. Pertinent Data

a. Drainage area. 1.7 mi^2.

b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 48 hours duration was divided into 15-minute intervals in order to develop the inflow hydrograph.

c. Lag time. 0.5 hrs.

d. Hydrologic soil group. C and D.

e. SCS curve numbers.

1. For PMF- AMC III - Curve Number 88.
2. For 1 and 10 percent probability-of-occurrence events - AMC II - Curve Number 74.

f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Greeley and Oates, MO, 7.5-minute quadrangle maps (1967). The data were entered on the $A and $E cards so that the HEC-1 program could compute storage volumes.

g. Outflow over dam crest. The profile of the dam crest is regular.

h. Outflow capacity. The spillway rating curve was developed from the cross section data of the spillway using the HEC-2 backwater program. The results of the above were entered on the Y4 and Y5 cards of the HEC-1 program.

i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 1041.9 ft, the spillway crest elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 1041.9 ft, the spillway crest elevation.

B.3. Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the results' summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
 LAST MODIFICATION  26 FEB 79
**********
    1          A1       DAM NO. 30330  BRUSHY CREEK (ST. JOSEPH LEAD CO.)
    2          A2       WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
    3          A3       PROBABLE MAXIMUM FLOOD (PMF)
    4          B    200       0      15       0       0       0       0       0       0       0
    5          B1     5
    6          J      1       2       1
    7          J1   .50     1.0
    8          K      0    LAKE                                          1
    9          K1       PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH CALCULATION
   10          M      1       2     1.7                     1.0
   11          P      0    26.0     102     120     130     140
   12          T                                                  -1     -88             .015
   13          W2           1.2
   14          X     -1    -.05       5
   15          K      1     DAM                                    1
   16          K1       PMF ROUTING AND OVERTOPPING ANALYSIS
   17          Y                                      1       1
   18          Y1     1                                                -1041.9      -1
   19          Y41041.9  1042.4  1042.9  1043.8  1045.9  1047.6  1048.7  1050.2  1051.2
   20          Y5     0.    10.0    50.0   200.0   800.0  1500.0  2000.0  3000.0  4000.0
   21          SA     1.      6.     12.    13.5    18.2    20.0    32.0
   22          SE1020.0  1030.0  1040.0  1041.9  1048.5  1050.0  1060.0
   23          SS1041.9
   24          SD1048.5     3.0     1.5    465.
   25          K     99
```

Input Data
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
B4

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
LAST MODIFICATION  26 FEB 79
**********

RUN  DATE? 81/02/05.
     TIME? 14.51.30.

DAM NO. 30330  BRUSHY CREEK (ST. JOSEPH LEAD CO.)
WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
PROBABLE MAXIMUM FLOOD (PMF)

                    JOB SPECIFICATION
   NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   MSTAN
  200       0      15       0       0       0       0       0       0       0
                      JOPER     NWT   LROPT   TRACE
                          5       0       0       0

          MULTI-PLAN ANALYSES TO BE PERFORMED
              NPLAN= 1 NRTIO= 2 LRTIO= 1
   RTIOS=     .50   1.00

**********  **********  **********  **********  **********

                SUB-AREA RUNOFF COMPUTATION

     PROBABLE MAXIMUM FLOOD INFLOW HYDROGRAPH CALCULATION

          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
          LAKE       0       0       0       0       0       1       0       0

                    HYDROGRAPH DATA
   IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW   ISAME   LOCAL
       1       2    1.70    0.00    1.70    1.00   0.000      0       0       0

                      PRECIP DATA
    SPFE     PMS      R6      R12     R24     R48     R72     R96
    0.00   26.00  102.00  120.00  130.00  140.00    0.00    0.00

                      LOSS DATA
  LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
      0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -88.00    0.00     .02

  CURVE NO =  -88.00  WETNESS =   -1.00  EFFECT CN =   88.00

                    UNIT HYDROGRAPH DATA
              TC=  0.00     LAG=  1.20

                    RECESSION DATA
          STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 5.00

 UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   1.20  VOL= 1.00
    57.    175.    369.    546.    616.    602.    523.    415.    286.    209.
   157.    116.     85.     62.     46.     33.     25.     18.     13.     10.
     7.      6.      4.      3.      2.      1.

 0                    END-OF-PERIOD FLOW
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Output Summary
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
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Output Summary
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
B6

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
						END-OF-PERIOD FLOW							
1.01	.15	1	.00	.00	.00	1.	1.02	1.15	101	.04	.04	.01	98.
1.01	.30	2	.00	.00	.00	1.	1.02	1.30	102	.04	.04	.01	98.
1.01	.45	3	.00	.00	.00	1.	1.02	1.45	103	.04	.04	.01	116.
1.01	1.00	4	.00	.00	.00	1.	1.02	2.00	104	.04	.04	.00	130.
1.01	1.15	5	.00	.00	.00	1.	1.02	2.15	105	.04	.04	.00	140.
1.01	1.30	6	.00	.00	.00	1.	1.02	2.30	106	.04	.04	.00	147.
1.01	1.45	7	.00	.00	.00	1.	1.02	2.45	107	.04	.04	.00	153.
1.01	2.00	8	.00	.00	.00	1.	1.02	3.00	108	.04	.04	.00	157.
1.01	2.15	9	.00	.00	.00	1.	1.02	3.15	109	.04	.04	.00	160.
1.01	2.30	10	.00	.00	.00	1.	1.02	3.30	110	.04	.04	.00	163.
1.01	2.45	11	.00	.00	.00	0.	1.02	3.45	111	.04	.04	.00	165.
1.01	3.00	12	.00	.00	.00	0.	1.02	4.00	112	.04	.04	.00	166.
1.01	3.15	13	.00	.00	.00	0.	1.02	4.15	113	.04	.04	.00	169.
1.01	3.30	14	.00	.00	.00	0.	1.02	4.30	114	.04	.04	.00	169.
1.01	3.45	15	.00	.00	.00	0.	1.02	4.45	115	.04	.04	.00	170.
1.01	4.00	16	.00	.00	.00	0.	1.02	5.00	116	.04	.04	.00	170.
1.01	4.15	17	.00	.00	.00	0.	1.02	5.15	117	.04	.04	.00	171.
1.01	4.30	18	.00	.00	.00	0.	1.02	5.30	118	.04	.04	.00	171.
1.01	4.45	19	.00	.00	.00	0.	1.02	5.45	119	.04	.04	.00	172.
1.01	5.00	20	.00	.00	.00	0.	1.02	6.00	120	.04	.04	.00	172.
1.01	5.15	21	.00	.00	.00	0.	1.02	6.15	121	.20	.18	.02	181.
1.01	5.30	22	.00	.00	.00	0.	1.02	6.30	122	.20	.18	.01	206.
1.01	5.45	23	.00	.00	.00	0.	1.02	6.45	123	.20	.18	.01	250.
1.01	6.00	24	.00	.00	.00	0.	1.02	7.00	124	.20	.18	.01	335.
1.01	6.15	25	.02	.00	.01	0.	1.02	7.15	125	.20	.18	.01	423.
1.01	6.30	26	.02	.00	.01	0.	1.02	7.30	126	.20	.18	.01	509.
1.01	6.45	27	.02	.00	.01	0.	1.02	7.45	127	.20	.19	.01	585.
1.01	7.00	28	.02	.00	.01	0.	1.02	8.00	128	.20	.19	.01	649.
1.01	7.15	29	.02	.00	.01	1.	1.02	8.15	129	.20	.19	.01	698.
1.01	7.30	30	.02	.00	.01	1.	1.02	8.30	130	.20	.19	.01	721.
1.01	7.45	31	.02	.00	.01	1.	1.02	8.45	131	.20	.19	.01	745.
1.01	8.00	32	.02	.00	.01	1.	1.02	9.00	132	.20	.19	.01	765.
1.01	8.15	33	.02	.00	.01	1.	1.02	9.15	133	.20	.19	.01	779.
1.01	8.30	34	.02	.00	.01	1.	1.02	9.30	134	.20	.19	.01	790.
1.01	8.45	35	.02	.00	.01	1.	1.02	9.45	135	.20	.19	.01	799.
1.01	9.00	36	.02	.00	.01	1.	1.02	10.00	136	.20	.19	.01	806.
1.01	9.15	37	.02	.00	.01	1.	1.02	10.15	137	.20	.19	.01	811.
1.01	9.30	38	.02	.00	.01	1.	1.02	10.30	138	.20	.19	.01	816.
1.01	9.45	39	.02	.00	.01	1.	1.02	10.45	139	.20	.19	.01	820.
1.01	10.00	40	.02	.00	.01	1.	1.02	11.00	140	.20	.19	.00	823.
1.01	10.15	41	.02	.00	.01	1.	1.02	11.15	141	.20	.19	.00	825.
1.01	10.30	42	.02	.00	.01	2.	1.02	11.30	142	.20	.19	.00	827.
1.01	10.45	43	.02	.00	.01	3.	1.02	11.45	143	.20	.19	.00	829.
1.01	11.00	44	.02	.00	.01	3.	1.02	12.00	144	.20	.19	.00	831.
1.01	11.15	45	.02	.00	.01	4.	1.02	12.15	145	.66	.65	.01	858.
1.01	11.30	46	.02	.00	.01	5.	1.02	12.30	146	.66	.65	.01	940.
1.01	11.45	47	.02	.00	.01	6.	1.02	12.45	147	.66	.65	.01	1111.
1.01	12.00	48	.02	.00	.01	8.	1.02	13.00	148	.66	.65	.01	1363.
1.01	12.15	49	.05	.01	.04	9.	1.02	13.15	149	.80	.79	.01	1656.
1.01	12.30	50	.05	.01	.04	12.	1.02	13.30	150	.80	.79	.01	1990.
1.01	12.45	51	.05	.02	.03	17.	1.02	13.45	151	.80	.79	.01	2280.
1.01	13.00	52	.05	.02	.03	24.	1.02	14.00	152	.80	.79	.01	2516.
1.01	13.15	53	.06	.03	.04	33.	1.02	14.15	153	.99	.99	.01	2749.
1.01	13.30	54	.06	.03	.03	44.	1.02	14.30	154	.99	.99	.01	2997.
1.01	13.45	55	.06	.03	.03	56.	1.02	14.45	155	.99	.99	.01	3174.
1.01	14.00	56	.06	.03	.03	69.	1.02	15.00	156	.99	.99	.01	3303.
1.01	14.15	57	.08	.04	.03	82.	1.02	15.15	157	1.01	1.00	.00	3596.
1.01	14.30	58	.08	.04	.03	95.	1.02	15.30	158	2.02	2.01	.01	3834.
1.01	14.45	59	.08	.05	.03	110.	1.02	15.45	159	5.64	5.63	.02	4369.

1.01	14.00	56	.06	.03	.03	69.	1.02	15.00	156	.99	.99	.01	3393.
1.01	14.15	57	.08	.04	.03	82.	1.02	15.15	157	1.01	1.00	.00	3596.
1.01	14.30	58	.08	.04	.03	95.	1.02	15.30	158	2.02	2.01	.01	3834.
1.01	14.45	59	.08	.05	.03	110.	1.02	15.45	159	5.64	5.63	.02	4369.
1.01	15.00	60	.08	.05	.03	126.	1.02	16.00	160	1.41	1.41	.00	5256.
1.01	15.15	61	.08	.05	.03	142.	1.02	16.15	161	.93	.93	.00	6462.
1.01	15.30	62	.16	.11	.05	161.	1.02	16.30	162	.93	.93	.00	7482.
1.01	15.45	63	.43	.33	.11	197.	1.02	16.45	163	.93	.93	.00	7889.
1.01	16.00	64	.11	.09	.02	255.	1.02	17.00	164	.93	.93	.00	7767.
1.01	16.15	65	.07	.06	.01	333.	1.02	17.15	165	.73	.73	.00	7257.
1.01	16.30	66	.07	.06	.01	402.	1.02	17.30	166	.73	.73	.00	6535.
1.01	16.45	67	.07	.06	.01	435.	1.02	17.45	167	.73	.73	.00	5723.
1.01	17.00	68	.07	.06	.01	438.	1.02	18.00	168	.73	.73	.00	5134.
1.01	17.15	69	.06	.05	.01	417.	1.02	18.15	169	.07	.06	.00	4644.
1.01	17.30	70	.06	.05	.01	382.	1.02	18.30	170	.07	.06	.00	4159.
1.01	17.45	71	.06	.05	.01	340.	1.02	18.45	171	.07	.06	.00	3647.
1.01	18.00	72	.06	.05	.01	310.	1.02	19.00	172	.07	.06	.00	3039.
1.01	18.15	73	.00	.00	.00	284.	1.02	19.15	173	.07	.06	.00	2465.
1.01	18.30	74	.00	.00	.00	257.	1.02	19.30	174	.07	.06	.00	1948.
1.01	18.45	75	.00	.00	.00	226.	1.02	19.45	175	.07	.06	.00	1516.
1.01	19.00	76	.00	.00	.00	191.	1.02	20.00	176	.07	.06	.00	1179.
1.01	19.15	77	.00	.00	.00	156.	1.02	20.15	177	.07	.06	.00	942.
1.01	19.30	78	.00	.00	.00	123.	1.02	20.30	178	.07	.06	.00	769.
1.01	19.45	79	.00	.00	.00	96.	1.02	20.45	179	.07	.06	.00	640.
1.01	20.00	80	.00	.00	.00	75.	1.02	21.00	180	.07	.06	.00	542.
1.01	20.15	81	.00	.00	.00	60.	1.02	21.15	181	.07	.06	.00	476.
1.01	20.30	82	.00	.00	.00	49.	1.02	21.30	182	.07	.06	.00	422.
1.01	20.45	83	.00	.00	.00	41.	1.02	21.45	183	.07	.06	.00	382.
1.01	21.00	84	.00	.00	.00	35.	1.02	22.00	184	.07	.06	.00	351.
1.01	21.15	85	.00	.00	.00	31.	1.02	22.15	185	.07	.06	.00	330.
1.01	21.30	86	.00	.00	.00	28.	1.02	22.30	186	.07	.06	.00	317.
1.01	21.45	87	.00	.00	.00	25.	1.02	22.45	187	.07	.06	.00	307.
1.01	22.00	88	.00	.00	.00	23.	1.02	23.00	188	.07	.06	.00	300.
1.01	22.15	89	.00	.00	.00	22.	1.02	23.15	189	.07	.06	.00	295.
1.01	22.30	90	.00	.00	.00	21.	1.02	23.30	190	.07	.06	.00	291.
1.01	22.45	91	.00	.00	.00	20.	1.02	23.45	191	.07	.06	.00	288.
1.01	23.00	92	.00	.00	.00	20.	1.03	0.00	192	.07	.06	.00	286.
1.01	23.15	93	.00	.00	.00	20.	1.03	.15	193	0.00	0.00	0.00	281.
1.01	23.30	94	.00	.00	.00	19.	1.03	.30	194	0.00	0.00	0.00	270.
1.01	23.45	95	.00	.00	.00	19.	1.03	.45	195	0.00	0.00	0.00	246.
1.02	0.00	96	.00	.00	.00	19.	1.03	1.00	196	0.00	0.00	0.00	210.
1.02	.15	97	.04	.04	.01	21.	1.03	1.15	197	0.00	0.00	0.00	179.
1.02	.30	98	.05	.04	.01	27.	1.03	1.30	198	0.00	0.00	0.00	152.
1.02	.45	99	.04	.04	.01	39.	1.03	1.45	199	0.00	0.00	0.00	130.
1.02	1.00	100	.04	.04	.01	57.	1.03	2.00	200	0.00	0.00	0.00	110.
									SUM	36.40	34.84	1.56	152709.
										(925.11	885.11	40.11	4324.12)

Output Summary
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
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	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	7889.	4509.	1518.	763.	152661.
CMS	223.	128.	43.	22.	4323.
INCHES		24.67	33.23	34.41	34.81
MM		626.66	844.09	884.08	884.08
AC-FT		2236.	3011.	3154.	3154.
THOUS CU M		2758.	3715.	3891.	3891.

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

1.	1.	1.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
								1.	1.

Output Summary
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
B8

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2
HYDROGRAPH AT	LAKE	1.70	1	.50	1.00
		4.401		1111.701)	223.401)
ROUTED TO	DAM	1.70	1	3918.	7830.
		4.401		110.941)	221.711)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1041.90	1041.90	1048.50
STORAGE	144.	144.	248.
OUTFLOW	0.	0.	1909.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	1049.50	1.00	267.	3918.	3.00	41.00	0.00
1.00	1050.65	2.15	290.	7830.	5.75	40.75	0.00

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .25	RATIO 2 .30	RATIO 3 .35	RATIO 4 .40
HYDROGRAPH AT	LAKE	1.70	1	1972.	2367.	2761.	3156.
		(4.40)	(	55.85)(	67.02)(	78.19)(	89.36)(
ROUTED TO	DAM	1.70	1	1810.	2315.	2743.	3134.
		(4.40)	(	51.26)(	65.54)(	77.67)(	88.74)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1041.90	1041.90	1048.50
STORAGE	144.	144.	248.
OUTFLOW	0.	0.	1909.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	1048.28	0.00	244.	1810.	0.00	41.25	0.00
.30	1048.81	.31	254.	2315.	1.00	41.00	0.00
.35	1049.02	.52	258.	2743.	1.75	41.00	0.00
.40	1049.19	.69	261.	3134.	2.25	41.00	0.00

Output Summary
Various PMF Events
Brushy Creek Mine Water
Clarification Dam
MO 30330
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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
               A1      DAM NO. 30330  BRUSHY CREEK (ST. JOSEPH LEAD CO.)
               A2      WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C224
               A3      PROBABLE FLOOD  100-YEAR
               B    200      0     15      0      0      0      0      0      0      0
               B1     5
               K      0    LAKE                                 1
               K1  RAIN STA--18-LESTRVL -- FREQ= 1.0% -- INTERVAL=  15MIN -- DURATION=  48HR
               N      0      2    1.7                    1.0
               O    192  8.838               DA =   5.00
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .016   .016   .016   .016
               O1  .016   .016   .016   .016   .016   .016   .021   .021   .021   .021
               O1  .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
               O1  .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
               O1  .041   .041   .041   .041   .042   .042   .042   .042   .042   .042
               O1  .042   .042   .042   .042   .042   .042   .042   .042   .042   .042
               O1  .042   .041   .041   .041   .075   .076   .076   .076   .076   .076
               O1  .102   .102   .178   .180   .424   .769  1.685   .431   .181   .179
               O1  .102   .102   .076   .076   .076   .076   .076   .076   .021   .021
               O1  .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
               O1  .021   .021   .021   .021   .021   .021   .021   .021   .021   .021
               O1  .021   .021
               T                                              -1    -74           .015
               W2           1.2
               X     -1   -.05      5
               K      1    DAM                                  1
               K1      100-YEAR FLOOD ROUTING AND OVERTOPPING ANALYSIS
               Y                              1
               Y1     1                                    -1041.9     -1
               Y41041.9 1042.4 1042.9 1043.8 1045.9 1047.6 1048.7 1050.2 1051.2
               Y5    0.   10.0   50.0  200.0  800.0 1500.0 2000.0 3000.0 4000.0
               SA    1.     6.    12.   13.5   18.2   20.0   32.0
               SE1020.0 1030.0 1040.0 1041.9 1048.5 1050.0 1060.0
               $S1041.9
               $D1048.5    3.0    1.5   465.
               K     99
```

Input Data
1% Probability Event
Brushy Creek Mine Water
Clarification Dam
MO 30330
B10

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************

RUN  DATE? 81/02/05.
     TIME? 14.51.24.

              DAM NO. 30330  BRUSHY CREEK (ST. JOSEPH LEAD CO.)
              WOODWARD-CLYDE CONSULTANTS. HOUSTON JOB 80C224
              PROBABLE FLOOD  100-YEAR

                              JOB SPECIFICATION
       NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
      200       0      15       0       0       0       0       0       0       0
                            JOPER     NWT   LROPT   TRACE
                                3       0       0       0

     *********    *********    *********    *********    *********

                          SUB-AREA RUNOFF COMPUTATION

         RAIN STA--10-LESTRVL -- FREQ- 1.0: -- INTERVAL-  15MIN -- DURATION-  48HR

               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                LAKE       0       0       0       0       0       1       0       0

                               HYDROGRAPH DATA
       IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
           0       2    1.70    0.00    1.70    1.00   0.000       0       0       0

                                 PRECIP DATA
                           NP   STORM     DAJ     DAK
                          192    8.84    0.00    0.00
                                PRECIP PATTERN
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
      .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
      .04     .04     .04     .04     .08     .08     .08     .08     .08     .08
      .10     .10     .18     .18     .42     .77    1.69     .43     .18     .18
      .10     .10     .08     .08     .08     .08     .08     .08     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
      .02     .02

                                  LOSS DATA
    LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
```

Output Summary
1% Probability Event
Brushy Creek Mine Water
Clarification Dam
MO 30330

B11

.02 .02

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-74.00	0.00	.02

CURVE NO = -74.00 WETNESS = -1.00 EFFECT CN = 74.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 1.20

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 26 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 1.20 VOL= 1.00

57. 175. 369. 546. 616. 602. 523. 415. 286. 209.
137. 116. 89. 62. 46. 33. 25. 18. 13. 10.
7. 6. 4. 3. 2. 1.

END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.02	.00	.02	1.	1.02	1.15	101	.02	.01	.01	27.
1.01	.30	2	.02	.00	.02	1.	1.02	1.30	102	.02	.01	.01	28.
1.01	.45	3	.02	.00	.02	1.	1.02	1.45	103	.02	.01	.01	30.
1.01	1.00	4	.02	.00	.02	1.	1.02	2.00	104	.02	.01	.01	32.
1.01	1.15	5	.02	.00	.02	1.	1.02	2.15	105	.02	.01	.01	33.
1.01	1.30	6	.02	.00	.02	1.	1.02	2.30	106	.02	.01	.01	33.
1.01	1.45	7	.02	.00	.02	1.	1.02	2.45	107	.02	.01	.01	34.
1.01	2.00	8	.02	.00	.02	1.	1.02	3.00	108	.02	.01	.01	35.
1.01	2.15	9	.02	.00	.02	1.	1.02	3.15	109	.02	.01	.01	36.
1.01	2.30	10	.02	.00	.02	1.	1.02	3.30	110	.02	.01	.01	36.
1.01	2.45	11	.02	.00	.02	1.	1.02	3.45	111	.02	.01	.01	37.
1.01	3.00	12	.02	.00	.02	1.	1.02	4.00	112	.02	.01	.01	37.
1.01	3.15	13	.02	.00	.02	1.	1.02	4.15	113	.02	.01	.01	38.
1.01	3.30	14	.02	.00	.02	1.	1.02	4.30	114	.02	.01	.01	38.
1.01	3.45	15	.02	.00	.02	1.	1.02	4.45	115	.02	.01	.01	39.
1.01	4.00	16	.02	.00	.02	1.	1.02	5.00	116	.02	.01	.01	39.
1.01	4.15	17	.02	.00	.02	1.	1.02	5.15	117	.02	.01	.01	40.
1.01	4.30	18	.02	.00	.02	1.	1.02	5.30	118	.02	.01	.01	40.
1.01	4.45	19	.02	.00	.02	1.	1.02	5.45	119	.02	.01	.01	41.
1.01	5.00	20	.02	.00	.02	1.	1.02	6.00	120	.02	.01	.01	41.
1.01	5.15	21	.02	.00	.02	1.	1.02	6.15	121	.04	.02	.02	42.
1.01	5.30	22	.02	.00	.02	1.	1.02	6.30	122	.04	.02	.02	44.
1.01	5.45	23	.02	.00	.02	1.	1.02	6.45	123	.04	.02	.02	46.
1.01	6.00	24	.02	.00	.02	1.	1.02	7.00	124	.04	.02	.02	49.
1.01	6.15	25	.02	.00	.02	1.	1.02	7.15	125	.04	.02	.02	51.
1.01	6.30	26	.02	.00	.02	1.	1.02	7.30	126	.04	.02	.02	53.
1.01	6.45	27	.02	.00	.02	1.	1.02	7.45	127	.04	.02	.02	56.
1.01	7.00	28	.02	.00	.02	1.	1.02	8.00	128	.04	.02	.02	58.
1.01	7.15	29	.02	.00	.02	1.	1.02	8.15	129	.04	.02	.02	61.
1.01	7.30	30	.02	.00	.02	1.	1.02	8.30	130	.04	.02	.02	63.
1.01	7.45	31	.02	.00	.02	1.	1.02	8.45	131	.04	.02	.02	66.
1.01	8.00	32	.02	.00	.02	1.	1.02	9.00	132	.04	.02	.02	68.
1.01	8.15	33	.02	.00	.02	1.	1.02	9.15	133	.04	.02	.02	70.
1.01	8.30	34	.02	.00	.02	1.	1.02	9.30	134	.04	.02	.02	72.
1.01	8.45	35	.02	.00	.02	1.	1.02	9.45	135	.04	.02	.02	74.
1.01	9.00	36	.02	.00	.02	1.	1.02	10.00	136	.04	.02	.02	76.
1.01	9.15	37	.02	.00	.02	1.	1.02	10.15	137	.04	.03	.02	77.
1.01	9.30	38	.02	.00	.02	1.	1.02	10.30	138	.04	.03	.02	79.
1.01	9.45	39	.02	.00	.02	1.	1.02	10.45	139	.04	.03	.02	80.
1.01	10.00	40	.02	.00	.02	1.	1.02	11.00	140	.04	.03	.02	82.
1.01	10.15	41	.02	.00	.02	1.	1.02	11.15	141	.04	.03	.02	83.
							1.02	11.30	142	.04	.03	.02	84.

Output Summary
1% Probability Event
Brushy Creek Mine Water
Clarification Dam
MO 30330
B12

1.01	10.15	41	.02	.00	.02	1.	1.02	11.15	141	.04	.03	.02	108.
1.01	10.30	42	.02	.00	.02	1.	1.02	11.30	142	.04	.03	.02	109.
1.01	10.45	43	.02	.00	.02	1.	1.02	11.45	143	.04	.03	.01	110.
1.01	11.00	44	.02	.00	.02	1.	1.02	12.00	144	.04	.03	.01	111.
1.01	11.15	45	.02	.00	.02	1.	1.02	12.15	145	.07	.05	.03	113.
1.01	11.30	46	.02	.00	.02	1.	1.02	12.30	146	.08	.09	.03	117.
1.01	11.45	47	.02	.00	.02	1.	1.02	12.45	147	.08	.05	.03	120.
1.01	12.00	48	.02	.00	.02	1.	1.02	13.00	148	.08	.05	.02	139.
1.01	12.15	49	.02	.00	.02	1.	1.02	13.15	149	.08	.05	.02	155.
1.01	12.30	50	.02	.00	.01	2.	1.02	13.30	150	.08	.05	.02	170.
1.01	12.45	51	.02	.00	.01	2.	1.02	13.45	151	.10	.07	.03	184.
1.01	13.00	52	.02	.00	.01	2.	1.02	14.00	152	.10	.07	.03	199.
1.01	13.15	53	.02	.00	.01	3.	1.02	14.15	153	.18	.13	.05	218.
1.01	13.30	54	.02	.00	.01	3.	1.02	14.30	154	.18	.13	.05	245.
1.01	13.45	55	.02	.00	.01	4.	1.02	14.45	155	.42	.32	.10	269.
1.01	14.00	56	.02	.00	.01	4.	1.02	15.00	156	.76	.61	.16	390.
1.01	14.15	57	.02	.00	.01	5.	1.02	15.15	157	1.67	1.41	.26	665.
1.01	14.30	58	.02	.00	.01	5.	1.02	15.30	158	.43	.34	.05	942.
1.01	14.45	59	.02	.00	.01	6.	1.02	15.45	159	.18	.16	.02	1356.
1.01	15.00	60	.02	.00	.01	7.	1.02	16.00	160	.18	.16	.02	1696.
1.01	15.15	61	.02	.00	.01	7.	1.02	16.15	161	.10	.09	.01	1836.
1.01	15.30	62	.02	.00	.01	8.	1.02	16.30	162	.10	.09	.01	1795.
1.01	15.45	63	.02	.00	.01	8.	1.02	16.45	163	.08	.07	.01	1617.
1.01	16.00	64	.02	.00	.01	9.	1.02	17.00	164	.08	.07	.01	1369.
1.01	16.15	65	.02	.00	.01	9.	1.02	17.15	165	.09	.07	.01	1101.
1.01	16.30	66	.02	.00	.01	10.	1.02	17.30	166	.08	.07	.01	901.
1.01	16.45	67	.02	.00	.01	10.	1.02	17.45	167	.08	.07	.01	751.
1.01	17.00	68	.02	.00	.01	11.	1.02	18.00	168	.08	.07	.01	633.
1.01	17.15	69	.02	.00	.01	11.	1.02	18.15	169	.02	.02	.00	541.
1.01	17.30	70	.02	.00	.01	12.	1.02	18.30	170	.02	.02	.00	467.
1.01	17.45	71	.02	.00	.01	12.	1.02	18.45	171	.02	.02	.00	401.
1.01	18.00	72	.02	.00	.01	13.	1.02	19.00	172	.02	.02	.00	339.
1.01	18.15	73	.02	.00	.01	13.	1.02	19.15	173	.02	.02	.00	289.
1.01	18.30	74	.02	.00	.01	14.	1.02	19.30	174	.02	.02	.00	239.
1.01	18.45	75	.02	.00	.01	14.	1.02	19.45	175	.02	.02	.00	199.
1.01	19.00	76	.02	.00	.01	14.	1.02	20.00	176	.02	.02	.00	165.
1.01	19.15	77	.02	.00	.01	15.	1.02	20.15	177	.02	.02	.00	143.
1.01	19.30	78	.02	.00	.01	15.	1.02	20.30	178	.02	.02	.00	128.
1.01	19.45	79	.02	.00	.01	16.	1.02	20.45	179	.02	.02	.00	116.
1.01	20.00	80	.02	.00	.01	16.	1.02	21.00	180	.02	.02	.00	106.
1.01	20.15	81	.02	.00	.01	17.	1.02	21.15	181	.02	.02	.00	99.
1.01	20.30	82	.02	.00	.01	17.	1.02	21.30	182	.02	.02	.00	93.
1.01	20.45	83	.02	.00	.01	17.	1.02	21.45	183	.02	.02	.00	90.
1.01	21.00	84	.02	.00	.01	18.	1.02	22.00	184	.02	.02	.00	88.
1.01	21.15	85	.02	.00	.01	18.	1.02	22.15	185	.02	.02	.00	86.
1.01	21.30	86	.02	.00	.01	19.	1.02	22.30	186	.02	.02	.00	85.
1.01	21.45	87	.02	.00	.01	19.	1.02	22.45	187	.02	.02	.00	85.
1.01	22.00	88	.02	.00	.01	19.	1.02	23.00	188	.02	.02	.00	84.
1.01	22.15	89	.02	.01	.01	20.	1.02	23.15	189	.02	.02	.00	84.
1.01	22.30	90	.02	.01	.01	20.	1.02	23.30	190	.02	.02	.00	84.
1.01	22.45	91	.02	.01	.01	21.	1.02	23.45	191	.02	.02	.00	83.
1.01	23.00	92	.02	.01	.01	21.	1.03	0.00	192	.02	.02	.00	83.
1.01	23.15	93	.02	.01	.01	21.	1.03	.15	193	0.00	0.00	0.00	82.
1.01	23.30	94	.02	.01	.01	22.	1.03	.30	194	0.00	0.00	0.00	74.
1.01	23.45	95	.02	.01	.01	22.	1.03	.45	195	0.00	0.00	0.00	72.
1.02	0.00	96	.02	.01	.01	22.	1.03	1.00	196	0.00	0.00	0.00	61.
1.02	.15	97	.02	.01	.01	23.	1.03	1.15	197	0.00	0.00	0.00	52.
1.02	.30	98	.02	.01	.01	24.	1.03	1.30	198	0.00	0.00	0.00	45.
1.02	.45	99	.02	.01	.01	25.	1.03	1.45	199	0.00	0.00	0.00	38.
1.02	1.00	100	.02	.01	.01	26.	1.03	2.00	200	0.00	0.00	0.00	32.
									SUM	8.84	5.73	3.11	25100.
										224.11	146.11	79.11	710.751

Output Summary
1% Probability Event
Brushy Creek Mine Water
Clarification Dam
MO 30330
B13

RUNOFF SUMMARY. AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	LAKE	1836.	767.	253.	125.	1.70
	(	51.98)(	21.71)(	7.15)(	3.55)(	4.40)
ROUTED TO	DAM	1590.	756.	250.	122.	1.70
	(	45.04)(	21.40)(	7.07)(	3.45)(	4.40)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1

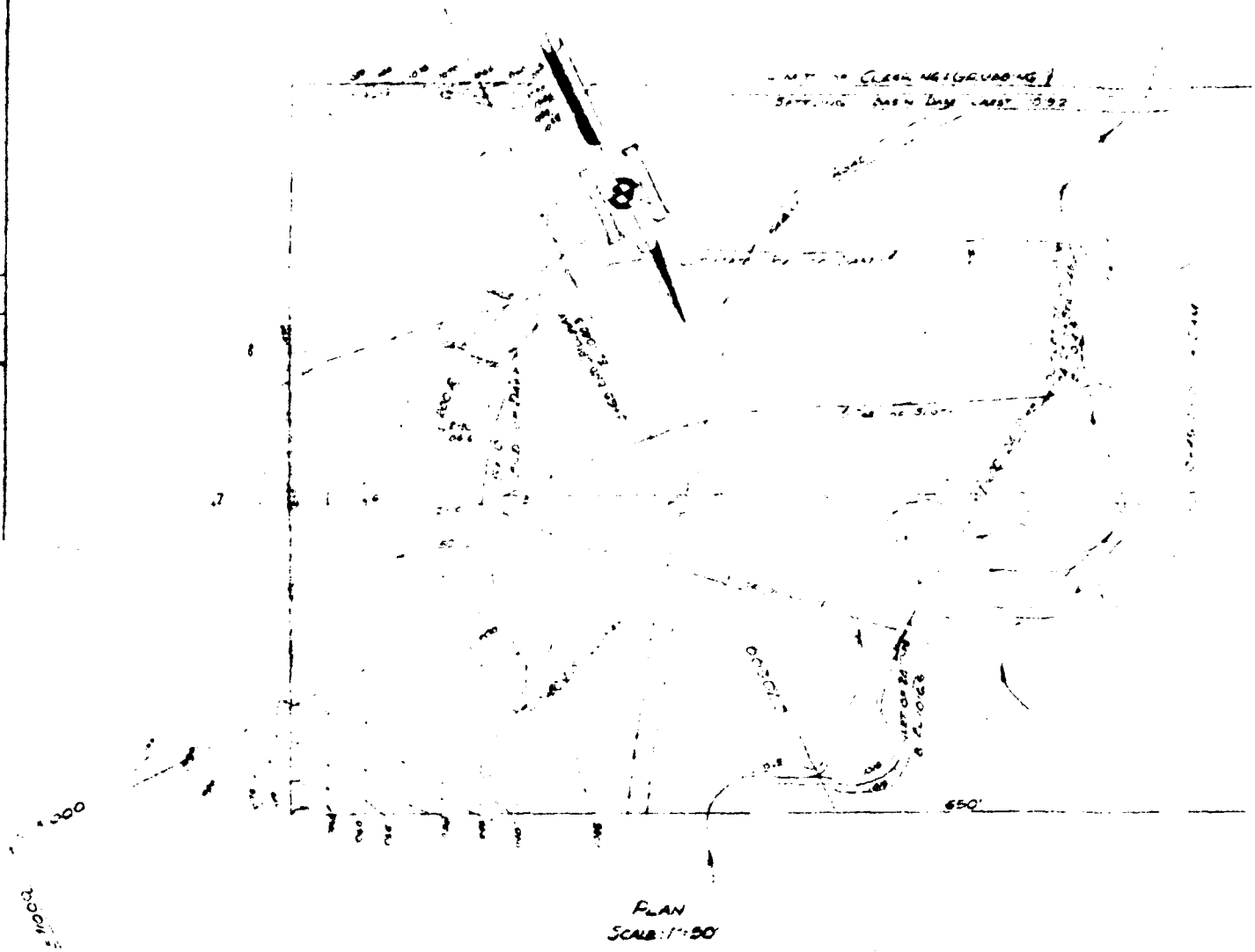
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1041.90	1041.90	1048.50
STORAGE	144.	144.	248.
OUTFLOW	0.	0.	1909.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.00	1047.80	0.00	236.	1590.	0.00	40.75	0.00

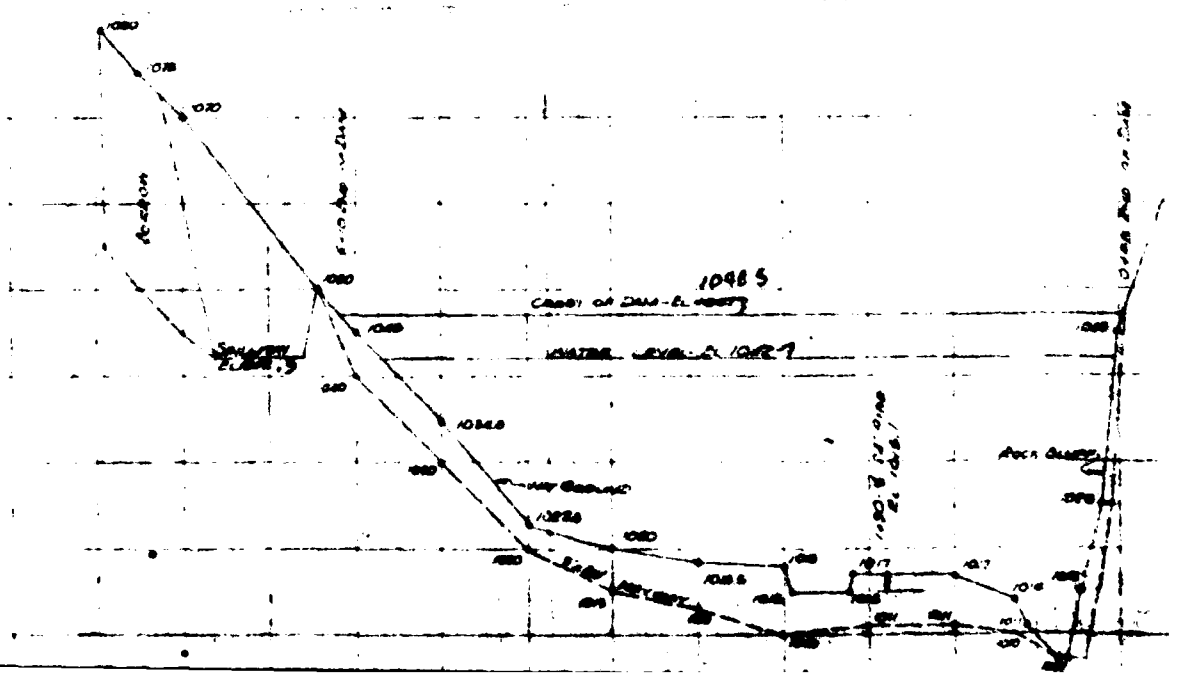
Output Summary
1% Probability Event
Brushy Creek Mine Water
Clarification Dam
MO 30330

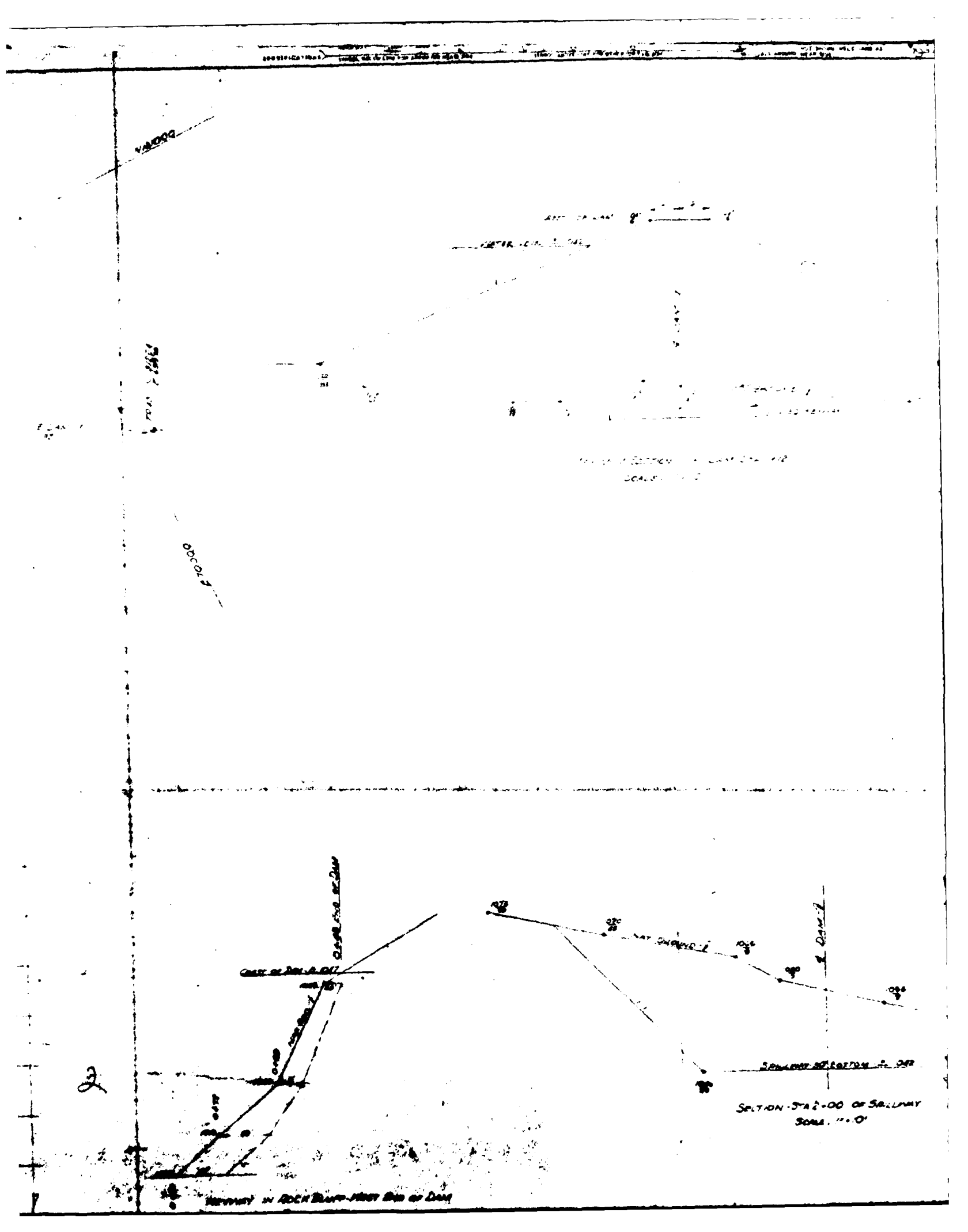
APPENDIX C

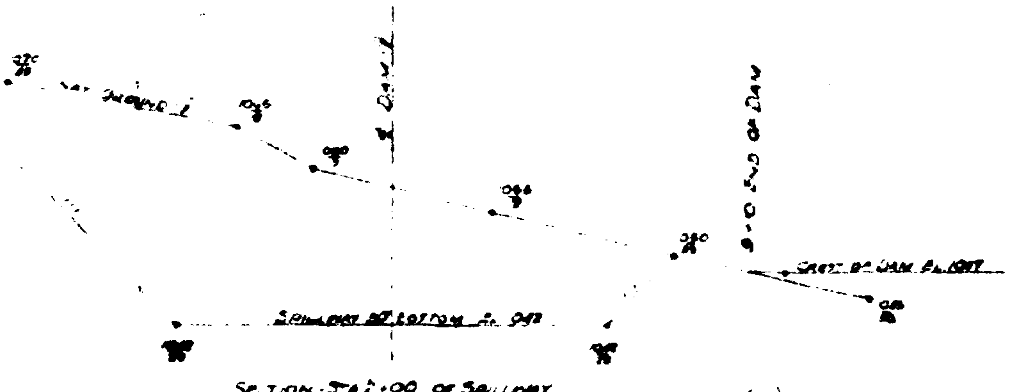
Design Drawings of Brushy Creek
Mine Water Clarification Dam



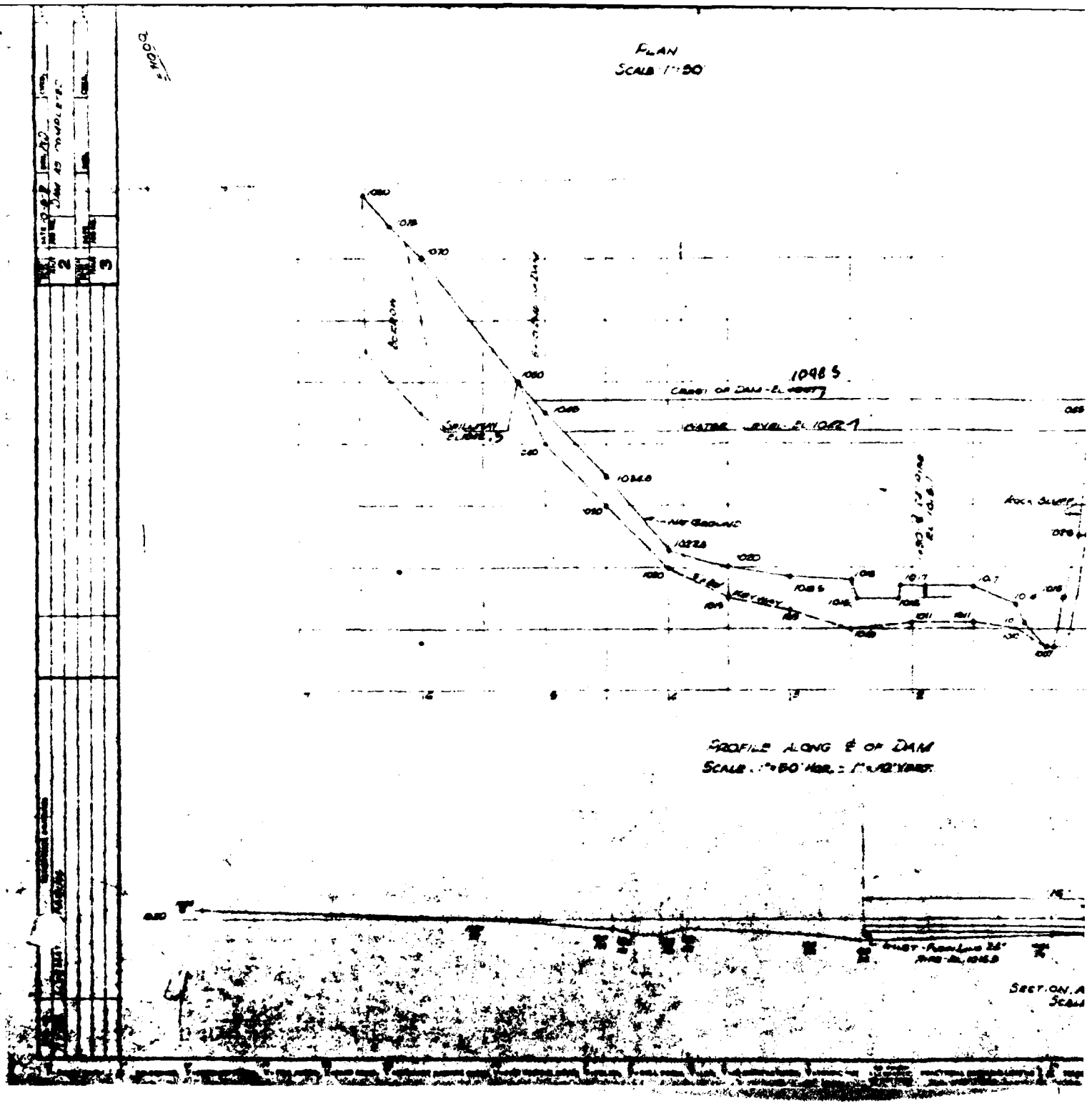
PLAN
SCALE: 1"=50'

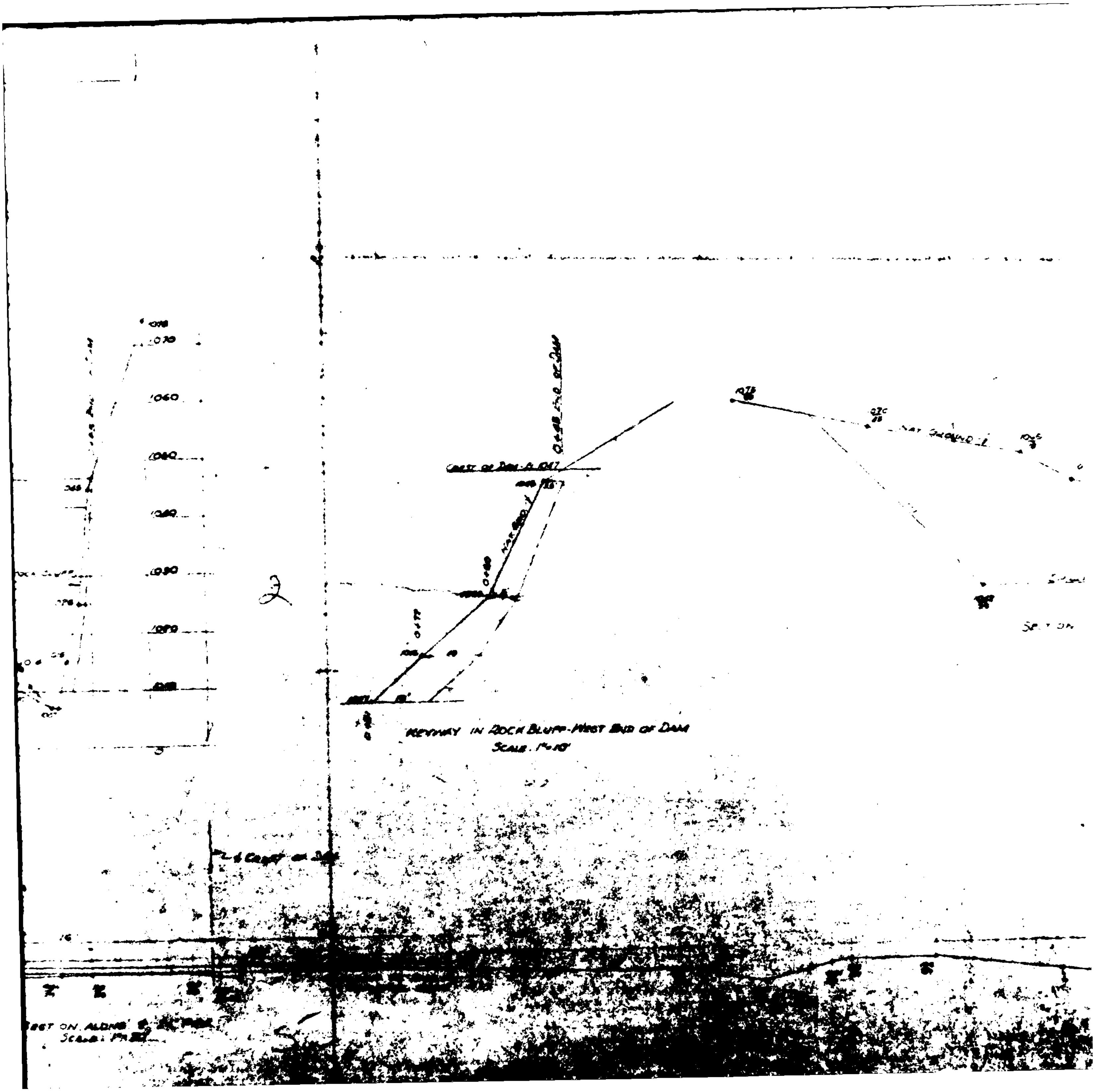


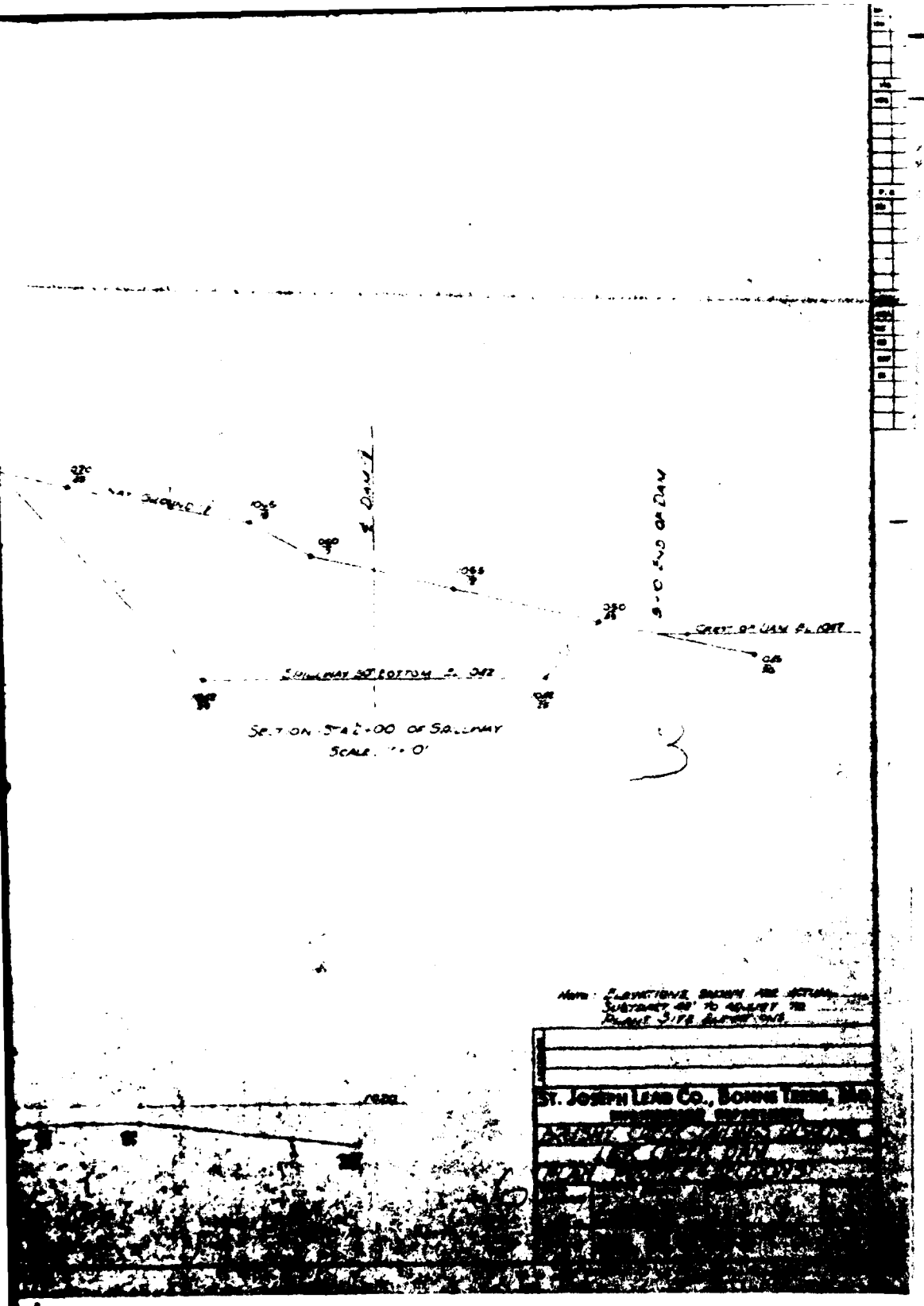

SECTION-STA 2+00 OF SPILLWAY
SCALE: 1"=10'



SECTION - STA. 2+00 OF SPILLWAY
SCALE 1" = [illegible]


PLAN
SCALE 1"=50'
1048.5
CREST OF DAM - EL 1057
WATER LEVEL EL 1052
SPILLWAY
EL 1048.5
ROCK SLOPE
PROFILE ALONG ℄ OF DAM
SCALE: 1"=50' HOR. = 1"=10' VERT.


1070
1060
CREST OF DAM EL 1047
KEYWAY IN ROCK BLUFF-WEST END OF DAM
SCALE: 1"=10'


SECTION STA 2+00 OF SPILLWAY
SCALE: 1" = 0'
ST. JOSEPH LEAD CO., BONNE TERRE, MO.

END

DATE
FILMED

11-81

DTIC